ELEMENTS OF MEDICAL MYCOLOGY

Top. Direct microscopic examination of skin scale showing branching septate mycelium × 400

Bottom. Infected hair showing numerous spores × 400

ELEMENTS OF MEDICAL MYCOLOGY

BY

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SECOND EDITION



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To

MY DEAR WIFE, JANET

in evidence of my appreciation of her encouragement and self sacrifice to make this and other works possible

INTRODUCTION TO THE FIRST EDITION

It is only within comparatively recent years that American medicine has known a text of any kind that was confined to mycology. At best information short of general medical literature in English and texts in foreign languages could be secured only in texts on tropical medicine and, in a small way indeed, in texts on bacteriology and general medicine. However, during the last thirteen years, four texts on mycology have made their appearance—one on cutaneous mycology, one that stresses taxonomy, one emphasizing clinical mycology, and a fourth dealing with fungi from the biologic angle. None of them is encyclopedic for the whole realm of mycology, to say the least.

It is in such a setting that this book of Dr Swartz's appears. It complements and amplifies the present supply of data, both in its text and in its illustrations.

The form that the book takes reflects the mycologic experience of its author. As a one-time pupil of Dr Carroll W. Dodge, he follows Dodge's classification of the fungi and has arranged his subject matter, including his chart, according to fungus genera. It is clear, too, that the laboratory aspects of mycology have become Dr Swartz's medical hobby, as evidenced by the majority of his illustrations. As a dermatologist, he devotes special space to ringworm. As a teacher he has properly indulged in photographs and charts; the illustrations are original with few exceptions.

The end result is a book that should answer the plea of that type of beginner in mycology, whether student or physician, who prefers to approach disease according to the tenets of the pathologist—that is, to begin with the cause and thereafter follow the course of events into symptomatology. For those who use the clinical approach, the book will be valuable in

PREFACE TO THE SECOND EDITION

It is now six years since the publication of the first edition of "Elements of Medical Mycology." Since then additional information and new technics have been advanced. A greater interest in the field of medical mycology, not only by dermatologists but also by internists and surgeons, has become manifest. The field of antibiotics and new chemotherapeutic agents has shown remarkable advances. For these reasons, then, a revised edition of this book seemed timely.

The style as presented in the first edition has been retained despite the increase in size. Clinical aspects are discussed in greater detail and are more fully illustrated. The less common diseases caused by fungi are included. The first two chapters deal with the classification of the pathogenic fungi and diagnostic procedures. The chapters which follow discuss the micro-organisms, the tissues attacked, diseases produced and treatment. The immune reactions and the antibiotics and newer chemotherapeutic agents are briefly reviewed.

This book is offered as a guide to students of mycology and dermatology as well as to internists and surgeons. It makes no pretense of being a complete reference book. For such purpose the reader is referred to the painstaking and thorough work of Carroll W. Dodge.

JACOB HYAMS SWARTZ, M.D.

Boston, April 1949

complementing the study of mycology through a second facet, thereby supplying the third dimension, so to speak, that could otherwise be obscured or lost by one eyed vision

FRED D WEIDMAN, M D

Philadelphia, August, 1943

ACKNOWLEDGMENTS

I am indebted to Dr Carroll W Dodge, whose pupil I am proud to have been He directed my early interests and efforts in the field of medical mycology I am also indebted to my former chief Clarence Guy Lane whose sound advice was freely given

I owe a particular debt of gratitude to my collaborator Dr Ethel M Rockwood who helped with the illustrations and read the manuscript

Dr Norman F Conant was generous in supplying illustrations of some of the rare fungus diseases

Dr Laurence L Robbins and Dr E B D Neuhauser supplied and helped interpret the x ray films

My associate Dr Earl A Glicklich made my task easier by relieving me of some of the office work

The following textbooks have been used as references in the writing of this book

- *Manual of Clinical Mycology* by N F Conant Ph D Donald S Martin M D David T Smith M D Roger D Baker M D and Jasper L Callaway M D (Philadelphia W B Saunders Company 1944)
- *Medical Mycology Fungous Diseases of Men and Other Mammals* by C W Dodge Ph D (St Louis C V Mosby Company 1935)
- *An Introduction to Medical Mycology* by George M Lewis M D and Mary E Hopper, M S (Chicago Year Book Publishers Inc 1939)
- *Fungous Diseases A Clinico-mycological Text,* by Harry P Jacobson M D (Springfield Ill Charles C Thomas 1932)
- *Precis de parasitologie* vol 2 by E Brump (Paris Masson et Cie 1936)

PREFACE TO THE FIRST EDITION

This text has been designed to serve the practitioner as a guide in the study of fungus diseases. The aims of simplicity and conciseness in both content and expression have required sacrifice of a certain amount of detail and of the discussion of certain of the rarer diseases. As a result, some of the statements that appear in the following pages may, to the experienced mycologist, because of the economy of detail, seem dogmatic.

If this small volume succeeds in its purpose of familiarizing students and physicians with the terminology of mycology, with the more common diseases produced by fungi, and with the laboratory procedures employed in diagnosis of these, the labor of compiling it will be sufficiently rewarded.

The book makes no pretense at serving the purposes of a definitive text. For such a work the reader is referred to the painstakingly thorough work of Dodge, which is the foundation on which this volume has been built.

JACOB HYAMS SWARTZ, M.D.

Boston, July, 1943

HISTORICAL NOTE

Mycology the study of fungi, came into existence before bacteriology It began when Hooke in 1677, constructed a magnifying lens and studied the yellow spots on the leaves of the damask rose and found that they consisted of filamentous organisms that he described in detail and illustrated with drawings

In 1686, Malpighi devoted a chapter to Plantis quae in aliis vegetant' In this chapter he mentions the genus Mucedo In 1729, Michelli described the genus Aspergillus among other fungi In 1752 Linnaeus in his book entitled *Species plantarum* summarized all that was known on the subject of fungi and also named a large number of species

A good deal of progress was made in mycology in the early part of the nineteenth century It was not until then that fungi parasitic to man began to attract attention The first important fungus discovered was that which causes thrush this organism was described by Langenbeck in 1839 In 1843 Charles Robin described the thrush fungus in detail Robin also wrote a book on mycology entitled *Histoire naturelle des végétaux parasites qui croissent sur l homme et sur les animaux vivants*

In 1843 Schoenlein discovered the fungus producing favus In that year Gruby described the fungus of ringworm and pointed out the difference between ringworm fungi of the large-spore and of the small spore type In 1846 Eichstedt discovered the fungus of tinea versicolor In 1870, Tilbury Fox described tinea pedis

Mycology continued to attract attention up to the time of the discoveries by Pasteur and Koch in the field of bacteriology these discoveries brought bacteriology into the foreground at the expense of mycology However in 1910 Sabouraud s scien

Three Thousand Mycological Terms, by Walter H Snell (Publication no 2, Rhode Island Botanical Club, Providence R I 1936)

Diagnosis and Treatment of Skin Diseases, by J H Swartz, M D and Margaret Gleason Reilly R N (New York Macmillan Company 1935)

J H S

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tific work on the subject of mycology brought to the fore a neglected and almost forgotten subject, his book *Les teignes* is a classic

Since then numerous workers both in this country and abroad have worked hard and made excellent progress on the subject of mycology Castellani merits mention for his work on the tropical mycoses Jadassohn and Bloch for their researches particularly in the field of immunology of fungus diseases, Mieschen Bruhns, and Alexander for their work on dermatophytes De Beurmann for his investigations of sporotrichosis

Outstanding in this country are the names of Weidman Hopkins Benham Williams Dodge, Henrici Emmons, Jacobson Martin, Conant Moore Lewis and Hopper, among the large number of workers who are continuing the researches in mycology begun in the early nineteenth century

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CHAPTER I

GENERAL DISCUSSION

Origin and Morphology of Fungi

THE FUNGI compose a large heterogeneous group of plants classified as thallophytes and characterized by their lack of chlorophyll. In contrast to the algae which obtain their nutrition from inorganic substances with the aid of chlorophyll and the sun's energy, the fungi live on decayed organic matter. Structurally, fungi show two distinct parts: the vegetative and the reproductive portions.

VEGETATIVE PORTION

This part is called the *thallus or mycelium* and is made up of septate filaments called *hyphae*. The latter are surrounded by cell wall. An exception are the few primitive families showing a naked and ameboid vegetative body. In a few groups the hyphal walls give the cellulose reaction but most of them give the chitin reaction. In fructifications and resting cells the hyphal wall first appears as a thin hyaline membrane that becomes thicker and may be further differentiated by secretions and deposits of minerals or resins or colored by pigments. The individual hyphae are generally intertwined in feltlike masses. Such a mass usually absorbs food at any point of the surface. Small mycelial branches that serve to attach the mycelium to the substrate and absorb the nutrients take on a specialized form and function in several groups. When the absorbing organs are rootlike they are described as *rhizoids*. When their function is purely that of attachment, the organs are called *holdfasts* (Rhizopus).

The septum often forms by furrowing. During rapid growth, there may be a delay in this septal development, later com

pensated by simultaneous or successive developments of septa In some species (viz Phycomycetes) the septa are entirely suppressed The whole mycelium is then a single, branched multinuclear mass of filaments becoming septate during the formation of reproductive organs or under conditions of poor nutrition

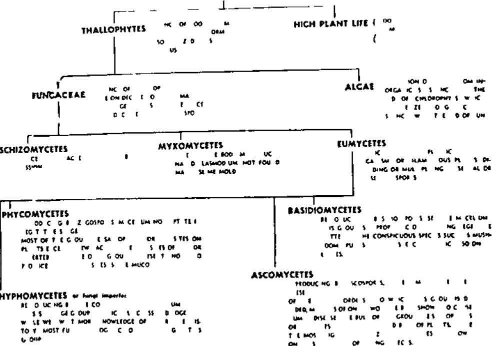
REPRODUCTIVE PORTION

This part is made up of *spores* Spores may be defined as characteristically formed cells or groups of cells that separate from the mother plant and take on an individual identity as new independent structures They serve a propagative purpose or that of resisting unfavorable environmental conditions The simplest form of development is that in which hyphal cells separate from the parent hyphae and develop into new hyphae These individual cells are called *arthrospores* or *thallospores* From these there is a gradual transition to more typical spores having a characteristic form The spores are in many cases formed by abstriction in others spores arise on specialized sporophores Sporophores to which specialized sporogenous cells are attached are known as *sporangiophores* The spores within the sporangia (specialized sporogenous cells) are termed *sporangiospores* Conidiophores are sporophores that abjoint their spores exogenously at their tips these spores are called *conidia* Spores may have a sexual origin representing the fusion of two cells or they may be asexual Most pathogenic fungi produce asexual spores some of them both sexual and asexual spores Those producing sexual spores are called *perfect fungi* those showing only the asexual type *imperfect fungi*

PHYSIOLOGY

GROWTH AND REPRODUCTION

Water The fungi grow and reproduce best in relatively high humidity This characteristic makes it possible by tran-


ORIGIN OF FUNGI
PLANT LIFE
THALLOPHYTES
HIGH PLANT LIFE
FUNGACEAE
ALGAE
SCHIZOMYCETES
MYXOMYCETES
EUMYCETES
PHYCOMYCETES
BASIDIOMYCETES
ASCOMYCETES
HYPHOMYCETES or fungi imperfec

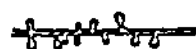
DEFINITIONS

THALLUS The entire vegetative portion of the fungus

HYPHA A chain of cylindric or club-shaped cells forming a filament



MYCELIUM A mass or collection of hyphae



SPOROPHORE A specialized hypha to which spores are attached



STERIGMA *A specialized hyphal cell to which spores are attached*

CLUBS Swollen hyphal tips varying greatly in size



SPIRALS Simple convoluted hyphae that may take all the forms of a tendril—from a spirillum like form to a closely set coil



RACQUET MYCELIUM Club-shaped cell the clubbed end of one cell being attached to the small end of an adjacent cell



CHLAMYDOSPORES Thallospores formed by the concentration of the protoplasm of a hypha within a swollen portion of the filament the membrane of which becomes thickened They are purely resting spores and are closely analogous in function to the spores of bacteria



FUSEAUX Large elongated chambered bodies looking very much like chlamydospores and divided into segments by parallel transverse septa

ENDOSPORE Any spore formed within a membrane of the parent cell



ASCOSPORES A special class of endospores formed in a membrane known as the ascus The number of spores in the sac is limited to two four or eight and is constant for the particular species producing them



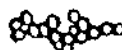
BASIDIOSPORE An exospore on a special type of sporophore known as a basidium

THALLOSPORE Cells that form a part of the vegetative portion of the fungus

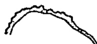


BLASTOSPORE A thallospore that develops by budding from the end or side of the parent cell and that may in turn throw out another bud or a mycelial filament without becoming detached and without any period of latency The buds of yeast cells are familiar examples

ARTHROSPORE Structures formed by the segmentation of a hypha into a chain of cells at first cubical and later rounded



CONIDIA Cells of irregular shape and size borne free and originating asexually from the mycelial threads by a process of budding septation or abstriction They may be pedunculated nonpedunculated lateral or terminal



PECTINATE BODIES Swollen and frequently curved ends of hyphae that give off a row of abortive branches from one side the structure vaguely resembling a comb



NODULAR BODIES Large rounded cells knotted together forming dense masses

ZYGOSPORE A sexual cell produced by the fusion of two undifferentiated cells

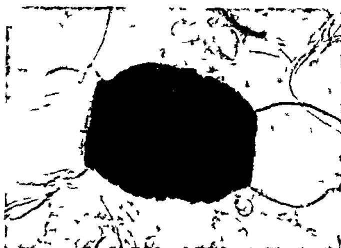


FIG 1 ZYGOSPORE FUSION OF TWO UNDIFFERENTIATED CELLS

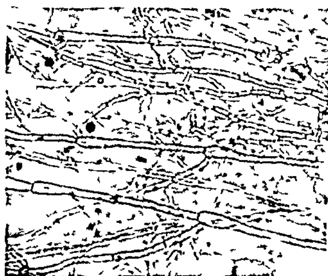


FIG 2 RACQUET MYCELIUM

ferring, in stock cultures to a 4 to 5 per cent agar instead of the 1 5 to 3 per cent commonly employed, to allow a much longer interval between transfers

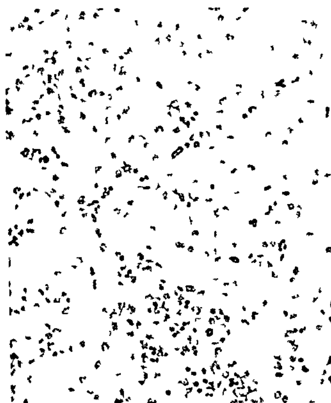


Fig 3 Ascospores

Oxygen The common pathogenic fungi require oxygen for growth and reproduction Actinomyces bovis however is an exception

Nitrogen The usual source of nitrogen in culture media is peptone In the skin keratin is the source of nitrogen The manner in which the skin fungi utilize the amino acid in keratin has not been determined It has been shown that most fungi require amino acids when grown on artificial media and that a suitable mixture of amino acids is desirable for the optimum growth and reproduction

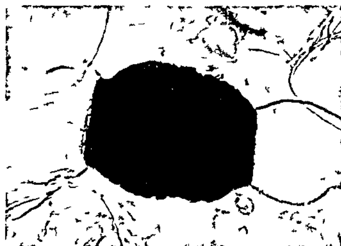


FIG 1 ZYGOSPORE FUSION OF TWO UNDIFFERENTIATED CELLS

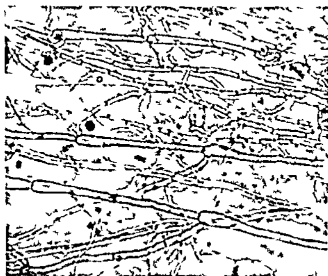


FIG 2 RACQUET MYCELIUM

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FIG 3 ASCOSPORES

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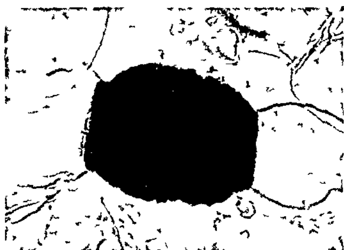


Fig 1 Zygospore Fusion of Two Undifferentiated Cells



Fig 2 Racquet Mycelium

ferring, in stock cultures to a 4 to 5 per cent agar instead of the 1.5 to 3 per cent commonly employed, to allow a much longer interval between transfers



FIG. 3. ASCOSPORES

Oxygen The common pathogenic fungi require oxygen for growth and reproduction. Actinomyces bovis, however, is an exception.

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Inorganic Salts Traces of potassium, magnesium, iron, and calcium are necessary to secure good growth and reproduction Of the nonmetallic elements, phosphorus, sulfur, carbon, and nitrogen are important

Hydrogen Ion Concentration Most fungi grow best in media supplying a concentration between pH 5 and pH 7

Temperature Optimum temperatures vary greatly with the species Some species grow well only at body temperature, others at any level between room and body temperature Most pathogenic fungi grow well at room temperature

Light Most pathogenic fungi develop as well in the dark as in light Ultraviolet rays of special wave lengths do have an inhibiting influence Roentgen rays have proved to have only slight inhibiting influence

Pigment Lewis and Hopper, in their study on the production of pigment, concluded that pigment is the product of metabolism Trichophyton rubrum and Microsporum canis were found to synthesize pigment in the presence of such monosaccharides as dextrose levulose and mannose and one disaccharide mannitol Pigment was not produced when the only sugars in the culture medium were disaccharides, trisaccharides polysaccharides and one monosaccharide, galactose Foster stresses the importance of available minerals particularly iron, copper and manganese

Classification of Pathogenic Fungi

The pathogenic fungi may be classified as follows

- I Yeast and yeastlike fungi
  - A Perfect
    - 1 Saccharomycetaceae (true yeast)
    - 2 Endomyces (auct) (filamentous yeast)
  - B Imperfect
    - 1 Cryptococcus (Torula)
    - 2 Candida (Monilia)
    - 3 Pityrosporum

II Ringworm fungi
1 Microsporum
2 Trichophyton
3 Epidermophyton
4 Endodermophyton

III Other pathogenic imperfect fungi
1 Coccidioides immitis
2 Paracoccidioides brasiliensis
3 Hormodendrum
4 Histoplasma capsulatum
5 Malassezia furfur (Microsporum furfur)
6 Microsporum minutissimum (Actinomyces minutissimus)
7 Sporotrichum
8 Actinomyces
9 Blastomyces dermatitidis

The pathogenic fungi may also be classified as follows

I The Superficial
1 Microsporum
2 Trichophyton
3 Epidermophyton
4 Malassezia furfur (Microsporum furfur)
5 Actinomyces minutissimus (Microsporum minutissimum)
6 Hormodendrum
7 Cryptococcus (Torula)
8 Candida (Monilia)

With the exception of Cryptococcus and Candida the fungi listed above are not known to attack the visceral organs although dissemination by the blood stream may occur

II The Deep These micro-organisms may attack visceral organs The skin may be of primary or secondary involvement
1 Actinomyces

2 Coccidioides immitis
3 Paracoccidioides brasiliensis
4 Blastomyces dermatitidis
5 Sporotrichum schenki
6 Histoplasma capsulatum
7 Cryptococcus neoformans
8 Candida albicans
9 Rhinosporidium seeberi
10 Aspergillus
11 Geotrichum

Fungi and Their Relation to Disease

The following is a classification of the pathogenic fungi, the tissues attacked by each, and the diseases they produce

Cryptococcus (Torula)
Nervous system meningitis
Skin cryptococcosis epidermica
European blastomycosis

Candida (Monilia)
Mucous membrane thrush
vaginitis
Skin moniliasis Folds, and interdigital areas on the hands are particularly susceptible
chronic paronychia
Lungs broncho pulmonary *moniliasis*
Systemic involvement positive blood cultures

Microsporum
M Canis (lanosum) animal type
Most frequently in this country tinea capitis in children occasionally, tinea barbae May involve glabrous skin in both children and adults
M audouini human type
Tinea capitis in children Rarely, attacks glabrous skin, producing abortive lesions More frequently found in England

M Gypseum (fulvum) animal type
Tinea capitis and glabrous skin involvement in children
Trichophyton schoenleini (Achorion schoenleini)
Scalp body, and nails favus
Trichophyton gypseum
Kerion
Tinea sycosis
Glabrous skin involvement
Trichophyton rubrum
Extensive glabrous skin involvement
Onychomycosis
Trichophyton rosaceum
Tinea sycosis
Onychomycosis
Trichophyton violaceum
Tinea capitis (black dot ringworm)
Kerion
Tinea sycosis
Glabrous skin involvement
Trichophyton tonsurans (T crateriforme)
Tinea capitis
Trichophyton sabouraudi (T acuminatum)
Tinea capitis
Trichophyton sulfureum
Tinea sycosis
Tinea capitis
Glabrous skin involvement
Epidermophyton floccosum (E inguinale)
Hands feet groins fungus infection (viz dermatophytosis also caused by Trichophyton family)
Endodermophyton (E concentricum) (T concentricum)
Skin Tokelau ringworm (tinea imbricata) Occurs in China the Malay Peninsula various Pacific islands
Malassezia furfur (Microsporum furfur)
Skin particularly upper trunk and extremities tinea versicolor

Actinomyces minutissimus (*Microsporum minutissimum*)
Skin particularly groins and axillae erythrasma

Hormodendrum

Philalophora verrucosa
Skin chromblastomycosis

Rhinosporidium seeberi
Anterior nares rhinosporidiosis

Blastomyces dermatitidis
Skin deep structures lungs, central nervous system (rarely) American blastomycosis

Sporotrichum (S schenckii)
Skin, systemic involvement sporotrichosis

Coccidioides immitis
Tissues of the pulmonary, osseous, cerebrospinal, and cutaneous systems, these appearing to bear the brunt of the infection (with the exception of the gastro intestinal tract, no part of the body is entirely immune) coccidioidomycosis (California disease), two forms—acute (valley fever) and granulomatous Endemic in certain parts of North America, sometimes benign, usually malignant and rapidly fatal Clinically simulates tuberculosis, syphilis, glanders, or neoplasm

Paracoccidioides brasiliensis
Skin, mucous membrane and visceral organs de Almeida's disease Lutz s disease, granuloma paracoccidioides

Actinomyces (Nocardia bovix N israeli)
Skin (particularly of head and neck), systemic involvement actinomycosis

Histoplasma capsulatum
Skin histoplasmosis (Darling s disease) Systemic (Reticuloendothelial cytomycosis)

Aspergillus (*A fumigatus A niger*)
Skin, nails and lungs aspergillosis

Geotrichum Lanl
Oral mucous membranes Broncho pulmonary geotrichosis

CHAPTER II

DIAGNOSIS OF FUNGUS INFECTION

THE DIAGNOSIS of fungus infection is made on the basis of the clinical picture It can be confirmed by the following laboratory procedures

1 Direct microscopic examination
2 Cultural characteristics
   a) culture media
   b) gross appearance
   c) microscopic appearance
   d) fusion of mycelium
   e) fermentation test
3 Filtered ultraviolet radiation
4 Cutaneous test
5 Animal inoculation
6 Agglutination test
7 Precipitation and complement fixation tests
8 Histologic examination
9 Roentgenologic examination

DIRECT MICROSCOPIC EXAMINATION

MATERIAL

A microscopic examination of the suspected material is requisite in every case diagnosed as fungus infection The selection of proper material is important since hit-or miss selection accounts for many negative findings It is wise also, to take plenty of material for both culture and direct microscopic study

In tinea capitis the stumps of hairs make the best material in tinea barbae both the involved hairs and the contents of the abscesses are used In tinea of the glabrous skin (viz,

tinea cruris, tinea circinata, or dermatophytosis of the hands or feet), the skin scrapings must be taken from the margins and rolled toward the normal skin, or from the roofs of the vesicles. In blastomycosis, we look for double-contoured bodies in the pus; they may also be seen in tissue in or outside the giant cells. In actinomycosis, the sulfur granules in the discharge are the best material for study. If mycosis of the lungs is suspected, a specimen of the sputum or preferably fragment of tissue or secretion obtained by bronchoscopic examination should be used for direct microscopic examination and cultural studies.

APPARATUS

The essential equipment for direct microscopic examination of the material in question comprises the following:

1. Epilating forceps for removal of hairs.
2. *Small curette or epilating forceps for glabrous skin.*
3. Sharp pointed toothpick to help in transferring the scales from the forceps or curette to the slide.
4. Several glass slides and a cover glass thoroughly cleansed with alcohol.
5. Tuberculin syringe and 20 gage needle to aspirate pus.
6. Scalpel to cut up coarse scales and nails.
7. Small curette for obtaining nail material.
8. Ten per cent solution of cresol for sterilizing curettes and scalpels.

TECHNIC

Place the material on a slide, adding a few drops of 20 to 40 per cent sodium or potassium hydroxide, preferably the latter. Cover with a cover glass, heat slightly, and allow to clear for ten or fifteen minutes before examining under the microscope. *Do not mistake fat* globules or air bubbles for spores. Do not mistake potassium hydroxide crystals for branching mycelia. Do not use too much potassium hydroxide in preparing the

slide, it will run over the cover glass and the preparation will be messy and unsatisfactory

Do not boil the potassium hydroxide when warming the slide

Do not rely on a single negative microscopic finding. Examine at least three preparations

Stains for Hair and Scales Staining is necessary for permanent preparation, since potassium hydroxide in a few days or even hours destroys the mycelium and the outline of the spores Of the staining procedures described in the literature the following deserve especial mention

Adamson (1895) recommended clearing with 5 to 10 per cent potassium hydroxide and staining by the Gram method Chalmers and Marshall (1914) suggested soaking scales for some hours in 40 per cent potassium hydroxide placed on a watch glass in the incubator at 40 C then transferring the specimens to watch glass containing 15 per cent alcohol After thirty minutes they should be removed to a slide the alcohol being allowed to evaporate After drying over a flame the specimens are stained with aniline gentian violet over a thirty minute period They are then treated for three minutes with Gram's iodine solution decolorized for thirty minutes with aniline oil and stained for a minute in concentrated alcoholic eosin which is then washed off with aniline oil or clove oil Finally the specimens are treated with xylol and mounted in balsam

Unna's method (1891) is to rub the scales of the epidermis between two slides in a little glacial acetic acid The slides are then drawn apart and held briefly over a flame to dry With alcohol and ether the fat is removed and the preparations are stained in borax methylene blue

Unna Jr (1929) recommends the following modification of the Pappenheim Unna Sr method Fix the skin in absolute alcohol run it through alcohol to xylol and embed it in paraffin Cut 10 microns-thick sections of the skin stain them with pyronine-methyl green for five to ten seconds rinse in water

dry with absolute alcohol, and mount in balsam. The fungi are stained red, and the leukocytes green to blue green.

The Swartz Conant* stain has the advantage of (1) giving a permanent preparation for class demonstration, and (2) eliminating artefacts that might be mistaken for fungi. The technic is as follows. The cutaneous scales, nail scrapings, or hairs are given preliminary clearing with a 5 to 10 per cent solution of potassium hydroxide and transferred to a watch glass. Two or three minutes of washing with water will stop the action of the potassium hydroxide and the material is then transferred to a slide and gently heated in a drop of lactophenol-cotton blue and a cover glass pressed on the preparation. The epidermal cells are stained light blue, the granular protoplasmic content of the fungus a deep blue. The stained material may be mounted in clear lactophenol.†

Williams (1927) recommends the use of glycerin to replace the potassium hydroxide after the skin scale is treated with the latter (see p. 14). Such a preparation can last several months.

Stain for Sputum and Pus. The suspected sputum, pus, or exudate is put on a slide and 20 to 40 per cent potassium hydroxide is added. A cover glass is then placed over the mixture which is heated slightly, allowed to clear, and examined microscopically under high dry power for mycelium or spores. If

	Gm. or cc.
Lactic acid	1 0
Phenol crystals	1 0
Glycerin	2 0
Water (distilled)	1 0
Cotton blue (C 4B Poirrier)	0 0%

The last ingredient is added after the other ingredients have been dissolved with gentle warming.

† Langeron's *Précis de microscopie* gives this formula for lactophenol:

	Gm. or cc.
Lactic acid	1 0
Phenol crystals	1 0
Glycerin	2 0
Water (distilled)	1 0

fistulas draining sinuses or abscesses are present the material in order to avoid contaminants must be obtained from fresh lesions Sometimes several preparations must be examined before the organism is found The lactophenol–cotton blue stain is the most satisfactory, since it does away with some of the artefacts so easy to mistake for fungi

Wet India Ink Preparation This procedure is useful in demonstrating the capsule in Cryptococcus neoformans Weidman and Freeman described the technic as follows "A loopful of india ink is placed on a glass slide and a loopful of culture material is quickly emulsified in it A large cover slip is quickly applied and pressed gently"

Contrast Stain This is a new method described by one of the authors (J H S) The suspected material is cleared in 10 per cent potassium hydroxide until it has a semitransparency and a gelatinous consistency This may be done in a watch glass or under a cover slip on a slide The potassium hydroxide is then thoroughly washed out of the material with tap water using a fine pointed pipette The material is then further cleared by soaking in a lactophenol mixture (see p 16) until it becomes transparent It is then placed on a clean slide and the lactophenol is washed away with tap water If the material is rather thick it may be smeared gently by touching the top with the flat side of a cover slip then allowed to dry and passed through a flame three or four times and heat fixed If the skin scales do not dry easily the reverse side of the slide should be heated gently until the scales can be seen to adhere to the slide before heat fixing Phloxine B (5 per cent) is applied with a medicine dropper and heated gently over a flame for thirty to sixty seconds The slide is then washed well with tap water and blotted dry A few drops of the supernatant fluid of a lactophenol–cotton blue* and clove oil mixture equal

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* Lactophenol–cotton blue and clove oil in equal parts are mixed well in a test tube The clear supernatant fluid is drawn off with a capillary pipette Fresh preparation should be made weekly

parts, is applied to the smear and heated gently over the flame The tissue will stain light blue and the fungus will be stained red

The major artefacts are fat cells, potassium hydroxide branching crystals, and mosaic structures—the latter irregular-shaped motheaten like forms simulating mycelium, found in the intercellular spaces Most mycologists agree that these structures are not fungus mycelia, but disagree as to whether they are degenerated fungi, cholesterol intercellular artefacts, or a result of action of fungi on the metabolism of the epidermal cells

Cultural Characteristics

CULTURE MEDIA

Broadly speaking, media are either solid or liquid Solid media are the most widely used, except in certain physiologic and spore germination studies, where liquids are more useful Tap water, milk, and similar natural liquids used alone or in combination with one or more other substances were the most popular early media There have since come into use certain solutions of known chemical content that provide the various metallic elements necessary for growth, as well as one or more organic compounds containing the requisite carbon and nitrogen, such as the Czapek or Dox solution The former is

	Gm or cc
Distilled water	1 000 0
K_2HPO_4	1 0
KCl	0 5
$MgSO_4 7H_2O$	0 5
$FeSO_4$	0 01

There are in common use many formulas for both solid and liquid media containing aqueous extracts in the form of infusions or decoctions *Infusions are prepared by extracting the material, rather finely divided, and steeping it for an hour or more in water* The only one in use at present is the meat in

fusion A mixture of one part of finely chopped lean meat is macerated with two parts of distilled water and chilled for eighteen hours, with occasional stirring It is then strained while cold through a fine cloth and 1 per cent peptone and 0 5 per cent sodium chloride are added After heating of the preparation until solution is complete sodium hydroxide is added until the reaction is slightly alkaline (practically neutral to phenolphthalein) After heating on a water bath for thirty minutes over a free flame the mixture is filtered while still hot through paper or through cotton and cloth Finally one per cent of the desired nutrients is added and reaction adjusted as necessary

Because of greater speed of the process and low protein content vegetable decoctions make suitable media Duggar (1909) suggested the equivalent of 50 Gm dry weight of the substance for every 1 000 cc of water The plant should be washed peeled and sliced thin The proper amount of water is then added and the whole boiled in a steam sterilizer for two hours never being allowed to cook on the bottom of the container Water lost by evaporation must be replaced After the larger vegetable particles have been removed by straining the decoction is filtered through paper

The earliest types of solid media were slices or plugs of raw or cooked vegetables Raw vegetable must have the outer skin washed and sterilized either with alcohol allowed to evaporate or with sterile water washes Another requirement is a relatively dust and spore free atmosphere Cylinders of the vegetable cut out with a sterile cork bore of slightly smaller diameter than the test tube used are sliced diagonally and placed either in a special sterile test tube or in one containing one or two glass beads and a small amount of water To insure continued moisture of the surface of the slant glycerol is sometimes substituted for the water or used in addition to it It is well to keep in mind that the glycerol is a possible additional source of carbon

The other solid media are colloidal gels—either silicates, proteins, or carbohydrates The silicates, because they are difficult to prepare, are not practical The principal proteins are egg albumin and gelatin they are little used in mycology except in studies of the organism's ability to attack and digest protein The carbohydrate media, chiefly starches and agar, are the most frequently used

The most commonly used formulas for culture media are

SABOURAUD S MEDIUM

	Gm or cc
Maltose (*brute de Chanut*)	40 0
Peptone (*granulee de Chassaing*)	10 0
Agar agar	18 0
Distilled water	1 000 0

The mixture is dissolved in the autoclave filtered through paper poured into Erlenmeyer flasks to a depth of about 1 cm and sterilized once in the autoclave allowing the temperature to rise slowly to 120 C

The formula for Sabouraud s conservation agar is the same as that given above except for omission of the sugar This medium was first advocated by Sabouraud to prevent pleomorphism (the loss of cultural characteristics through excessive vegetative growth)

CONSERVATION AGAR MEDIUM

	Gm or cc
Peptone	10 0
Agar agar	18 0
Distilled water	1 000 0

WEIDMAN S MODIFICATION OF SABOURAUD S MEDIUM

	Gm or cc
Agar agar	18 0
Peptone (Fairchild)	10 0
Dextrose (American granular)	40 0
Water	1 000 0

1 Dissolve ingredients and filter through cheesecloth

2 Adjustment of pH is not necessary (the finished medium should have a pH of 5 0)

3 Sterilize at 100 C for thirty minutes on each of three successive days

CORN MEAL AGAR MEDIUM

	Gm or cc
Yellow corn meal	40 0
Agar agar	15 0
Distilled water	1 000 0

Mix the corn meal with 500 cc of water and keep heated to 65 C for one hour Then filter the mixture Dissolve agar in 500 cc water and mix the corn meal and the agar Filter through cotton while the flask is kept in a steam bath Fill test tubes with the desired amounts autoclave for 20 minutes at 15 pounds pressure slant tubes and cool long enough to solidify the medium

This medium particularly facilitates the differentiation of the various species of Candida (Monilia) Its chief value is to facilitate the study of characteristic spore formation It may be used in the study of spore formation in Cryptococcus and in some of the dermatophytes

Excellent results have frequently been reported with various fungi on carrot agar The following is a typical formula

TALCHI S CARROT AGAR MEDIUM

	Gm or cc
Carrots	500 0
Peptone (Rostock)	10 0
Agar agar	20 0
Water	1 000 0

POTATO-CARROT AGAR MEDIUM

	Gm or cc
Carrots	20 0
Potatoes	20 0
Agar agar	15 0
Distilled water	1 000 0

Wash and peel the vegetables cut into small pieces add 700 cc of water and boil the mixture until 500 cc remains Filter Dissolve the agar in 500 cc of water by heating and mix the agar and the vegetable mixture Put a measured amount in each test tube autoclave and slant

This medium is useful to demonstrate the pigment formation characteristic for the species

Widely used are the Currie (1917) and the Fulmer and Grimes (1923) formulas for synthetic media

	Gm or cc
Ammonium chloride	1 88
Dipotassium hydrogen phosphate	1 00
Calcium chloride	1 00
Sucrose	50 00
Agar agar	*15 00*
Water	1 000 00

WORT AGAR (DIFCO)

This medium is useful for the isolation and differentiation of the yeast and yeastlike organisms The *p*H of the medium is about 4 8 and therefore inhibits the growth of bacterial contaminants

ANAEROBIC MEDIUM (BREWER)*

This medium is obtained from Baltimore Biological Laboratory Baltimore Maryland

	Gm or cc
Pork infusion solids	1 0
Peptone (thio)	1 0
Sodium chloride	0 5
Sodium thioglycolate	0 1
Agar agar	0 05
Water qs ad	1 000 0

ANAEROBIC MEDIUM (NORRIS)

	Gm or cc
Soluble starch	2 0
Dipotassium hydrogen phosphate	0 2
Calcium chloride	0 05
Ferric chloride	0 01
Sodium nitrate	0 06
Asparagin	0 05
Agar agar	20 0
Water qs ad	1 000 0

The above two media are chiefly used to isolate Actinomyces

Bits of skin, nail clippings, horn, feathers, hair, and bone are not uncommonly employed as media in investigative work

Thorough cleansing and sterilization of all apparatus used in work with pure culture are essential Sterilization by chemical agents is accomplished by the use of (1) halogens—chlorine or iodine (2) salts and heavy metals—copper, mercury silver etc (3) organic compounds—formaldehyde phenol, salicylic compounds and volatile oils Sterilization by the use of such physical agents as heat and light is also possible The autoclave is the most effective means For most media, 10 to 20 pounds of pressure for a fifteen to twenty minute period is sufficient

Filtration To retain in proper condition biologic products easily altered by heat it is often necessary to filter them through a porcelain filter with pores so small that bacteria cannot pass through

The methods employed in isolation of micro-organisms are the following

1 *Culturing of Material Taken Directly from Lesions* (see pp 13–14)

2 *Simple Transfer* The technic is the same as that used in bacteriology This method is successful only when the colony is small and free of other organisms If slight contamination is present careful transfer from the colony under investigation may give a pure culture Otherwise dilution and plating out must be resorted to

3 *Dilution* About three agar tubes are melted and then cooled almost to the solidifying point The tube is inoculated held vertically, and rotated to mix the contents thoroughly A tiny drop of the melted medium is transferred to the second tube and the process is repeated several times until three tubes have been inoculated The contents of each tube are then poured into a Petri dish When solidified they are incubated until growth is evident Individual colonies are then transferred to slants

PRESERVATION OF FUNGI

Lewis and Hopper recommend the following method of preserving fungus colonies for demonstration purposes When a colony has reached the size of growth desired and a characteristic appearance, the cotton pledget is moistened with a 40 per cent solution of formaldehyde and replaced in the test tube After twenty-four hours the pledget is trimmed off even with the test tube and dipped in paraffin to prevent evaporation of moisture from the agar

Gross cultures are studied for (1) rate of growth (2) type of growth i e, smooth, granular, cottony, etc (3) pigment formation, (4) tendency to pleomorphism, (5) appearance of growth under a low power microscope

MICROSCOPIC APPEARANCE

The morphology of the organism is studied by taking a small amount of the growth, together with a little of the culture medium staining the preparation with lactophenol-cotton blue after it is placed on a slide, and examining it microscopically Examination is repeated at progressive stages of development Another method of examining an organism microscopically is the van Tieghem cell technic

Hanging-Drop Preparation (van Tieghem Cell) This is the method by which the morphology is studied while the colony is still growing A glass ring is cemented to a microscopic slide with wax (the latter made by melting pure beeswax and vaseline) and its top is coated with vaseline A drop of the culture medium or of water is placed in the bottom of the cell thus formed in order to produce a small moist chamber Another, smaller drop of water or medium is placed on a clean cover glass of sufficient diameter to cover the ring The inoculum is then placed in the center of this drop the whole seized by forceps, and quickly inverted and lowered to the glass ring, where it is pressed down gently until the soft vaseline seals the ring The cell may be placed on the stage of the microscope and the morphology studied from time to time

BINDING AGENTS

For permanent preparations it is essential to use binding agents The following are recommended

1 Duco cement
2 Clarite
3 Asphalt varnish
4 Polyvinyl alcohol Lactophenol-cotton blue tain may be mixed with the polyvinyl alcohol and thus have a combination clearing agent tain and binding agent
5 Noyer cement Mix resin 80 parts with lanolin 20 parts Heat till thoroughly mixed To u e it heat a heavy wire dip in the cement and streak along the edge of the cover lip It is necessary to work fast since the cement hardens quickly It may be necessary to heat the wire several times to smooth the cement along the edge of the cover slip

FUSION OF MYCELIUM

David on and his co workers have u ed this test to identify unknown species Their findings show that the mycelium of strains of the same species only will fuse when allowed to mingle The mycelium of two strains of Microsporum canis fuse for example while the mycelia of M canis and M audouini do not

FERMENTATION TEST

Hopkins Benham Castellani and others classify the yeasts and yeastlike fungi according to their fermentation reactions

Filtered Ultraviolet Radiation

The phenomenon of fluorescence may facilitate diagnosis in cases of tinea capitis tinea favosa and tinea versicolor It is a particularly valuable precautionary measure in cases in which a few infected hairs may have been overlooked in a patient about to be discharged as cured of his disease One must however guard against being deceived by the fluorescence produced by greases not removed from the scalp before examination

PROCEDURE

A Wood filter is attached to the window of an air cooled or water-cooled quartz light radiating ultraviolet rays, photographers' black cloth is used to shut out light around the filter The room is darkened and the rays directed at the questionable patches on the scalp or trunk Lewis reports successful use of these rays in identifying certain organisms in cultures

CUTANEOUS TEST

The trichophytin test is specific but not always diagnostic The reasons are two (1) not every patient with a fungus infection is sensitized, the virulent fungi for example, may not have the capacity to sensitize (2) a positive test may denote sensitization caused by a past infection and may bear no relationship to the clinical picture in question By and large the test is of questionable diagnostic value

ANIMAL INOCULATION

Inoculation of the fungus under investigation into susceptible laboratory animals may help to establish the pathogenicity of the organism It is also valuable in obtaining a pure strain of the fungus Animal inoculation is particularly useful in the study of the deep mycoses and of systemic infection For animal susceptibility, refer to chart at the end of the book

AGGLUTINATION TEST

Benham and Hopkins have used this test in the identification of various strains of Candida (Monilia) Conant uses the agglutination reaction as a supplementary diagnostic test in blastomycosis

Descriptions of other available laboratory methods of examination such as precipitation and complement fixation tests histologic studies, and roentgenologic examination, may be found in all standard texts on pathology bacteriology, and medicine

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CHAPTER III

BLASTOMYCETES. YEASTLIKE FUNGI

THE TERMS *Blastomycetes* or *yeastlike fungi* are applied to all fungi that reproduce principally by budding. We have omitted those fungi which show yeastlike growth only in tissue and when grown at 37 C, but not at room temperature. These fungi are discussed in Chapter VI. With the exception of Endomyces and Saccharomyces, they belong to the general class of Hyphomycetes or fungi imperfecti and include the following genera:

Saccharomyces
Endomyces
Cryptococcus (Torula)
Candida (Monilia)
Pityrosporum

Castellani's simplified classification of these yeastlike fungi is based on the presence or absence of mycelium and ascospores:

1. Budding	Cryptococcus (*Torula*)
2. Budding and mycelium	Candida (Monilia)
3. Budding and ascospores	Saccharomyces
4. Budding, ascospores, and mycelium	Endomyces

The fungi of these genera produce budding forms not only in lesions but in culture also. Contrasted with these are the genera Blastomyces, Paracoccidiodes, and Histoplasma, which produce budding forms in lesions but moldlike growths on all media at room temperature.

This chapter is devoted to a discussion of *Cryptococcus (Torula)*, Candida (Monilia), and Pityrosporum.

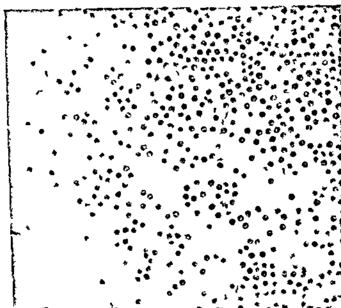


FIG 4 BUDDING AND NONBUDDING SPORES OF CRYPTOCOCCUS NEOFORMANS × 400

CRYPTOCOCCUS NEOFORMANS (SANFELICE VUILLEMIN 1901)

Synonyms Cryptococcus hominis Torula histolytica

MYCOLOGY

This fungus appears in tissue spinal fluid or pus as a single budding ovoid to spherical organism from 5 to 10 microns in diameter yeastlike in character, and surrounded by a wide gelatinous capsule The refractile capsule is a characteristic feature and i diagnostic for this fungus

Centrifuged sediment of spinal fluid or pus should be examined while fre h by placing a drop of the material on a slide and gently pressing it to a thin film under a cover glass The fungus is best detected under reduced light from the microscope condenser Pus may also be placed in a drop of india ink and

quickly examinated under a cover glass while still moist Frozen sections should be examined in wet Giemsa stain (undiluted) Recovery of Torula organisms from the blood stream has in a few cases been made by culture, they should be looked for in the urine also

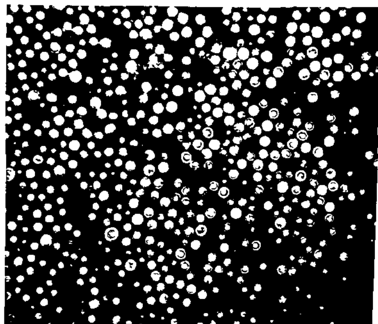


FIG 5 CRYPTOCOCCUS NEOFORMANS INDIA INK PREPARATION SHOWING CAPSULE × 400

Culture material grows well on both Sabouraud's glucose agar and blood agar at room and incubator temperatures Cultures should be kept for at least three weeks before being discarded The culture is yeastlike mucoid and brownish, it contains only budding cells with characteristic capsules

IMMUNOLOGIC REACTION

According to Benham agglutination reactions are absent

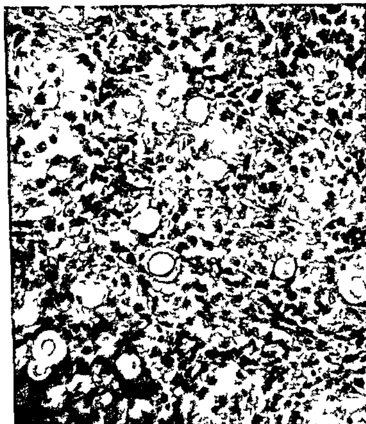


FIG 6 CRYPTOCOCCUS NEOFORMANS IN MOUSE LUNG × 400
Note encapsulated budding cell (Courtesy of Rhoda Benham)

Extracts of the organism are said to elicit specific cutaneous reactions in infected patients But the diagnostic value of such tests is doubtful

ANIMAL INOCULATION

The organism is inoculable in mice rats rabbits and guinea pigs the first two being most susceptible

CRYPTOCOCCOSIS (TORULOSIS OR EUROPEAN BLASTOMYCOSIS)

Cryptococcosis is an infection of animal or human tissue produced by Cryptococcus neoformans This organism reproduces only by budding without mycelial or endospore formation It does not ferment sugars It seems to have a special affinity for the tissues of the cerebrospinal system but may also attack the pulmonary system, as well as other organs and tissues of the body

Cryptococcosis in humans was first reported by Busse and Buschke from Germany (1894–95) in a patient with generalized lesions The causative organism, Cryptococcus neoformans (Torula histolytica), was isolated from a tibial abscess Curtis (1896) isolated this organism from a myxomatous tumor Because the early European cases showed skin lesions, Stoddard and Cutler (1916) did not associate their cases of so called torula meningitis with the earlier reports Freeman (1931) and Levine (1937) reviewed several cases of central nervous system involvement Cases of cutaneous involvement have been reported by Wile (1935) Kessel and Holtzwant (1935) and Dienst (1938) It can therefore be stated that torulosis may take the form of a generalized infection invading the central nervous system or occur as a localized infection of the skin

Cerebrospinal Torulosis The symptoms and signs are usually referable to the central nervous system persistent severe headache, stiff neck, vomiting paralysis, convulsive seizures, and decreased reflexes Eye changes such as disturbance of vision choked disk, diplopia, nystagmus, and strabismus are also characteristic The spinal fluid shows both increased pressure and increased cells chiefly lymphocytes Elevated albumin content and globulin count and a meningitic colloidal gold curve are sometimes observed Cutaneous lesions may accompany the meningitis, Weidman reports a granulomatous type

Pathologically, the picture is that of a chronic leptomeningitis The meninges are thickened, matted, and show adhe

sions to the cerebral cortex Exudation is scanty in amount Tubercles are found scattered throughout the involved tissues Little difference can be discovered microscopically between the meningeal lesions and those in the other infected organs In the brain substance itself are found perivascular granulomatous lesions and small nodules tubercles or glutinous cystlike structures distributed here and there throughout the cerebral tissues Microscopic examination reveals small spherical gelatinous spaces in which are imbedded numerous Torula organisms Cellular reaction around these lesions is almost negligible and the glia tissue about the focus is only slightly increased Large mononuclear and lymphocytic cells are found in and about the lesions Outside the brain the lesions of pulmonary and other forms of torulosis consist of small tubercles or nodules surrounded by what appear to be clear zones or halos The organism may be observed both intracellularly and extracellularly

The disease is slowly progressive and fatal death usually occurring as a result of respiratory failure

Pulmonary Torulosis This may be primary or secondary Sheppe records the only known case of the former type The secondary form of the disease occurs in approximately 42 per cent of recorded cases The clinical picture may be confused with that of tuberculosis syphilis or other pulmonary mycoses There is nothing characteristic about the pulmonary symptoms signs or x ray picture of patients with cryptococcosis The diagnosis of primary pulmonary cryptococcosis is usually made by cultural studies of the sputum and secretion obtained by bronchoscopic examination This should be done in every case of obscure pulmonary infection The diagnosis of secondary pulmonary cryptococcosis is not so difficult to make

Other Forms of Torulosis The organism may secondarily involve the spleen liver kidneys and mesenteric glands In fact an enlarged spleen and unexplained typhoid like fever should put the examiner on the alert for the presence of a

systemic yeastlike infection in cases where the possibility of typhoid, undulant fever, or similar infectious diseases has already been eliminated Superficial *café au lait* patches covered with furfuraceous scales may be seen on the eyelids, the neck, the flexures of the elbows, and the thighs Other skin manifestations are deep granulomatous lesions simulating



FIG 7 PULMONARY CRYPTOCOCCUS
Showing interstitial pneumonitis focal atelectasis and a large granulomatous lesion in the right upper lobe (Courtesy of E B D Neuhauser and Arthur Tucker Am J Roentgenol Vol LIX No 6 June 1948)

those of syphilis tuberculosis, and coccidioidomycosis Differential diagnosis can be made only on the basis of mycologic studies The blood findings are not distinctive A moderate leukocytosis (count of 8,000 to 25 000) is present the number of polymorphonuclear cells may or may not show slight increase

Treatment The *cutaneous* and *subcutaneous* lesions if local

ized are best treated by excision and drainage followed by filtered semi intensive roentgen ray therapy This may be supplemented by iodide therapy to a point of intolerance or by sulfonamide or penicillin or both to combat secondary bacterial infection The sulfonamides may also be effective in cryptococcosis in intensive doses Improvement with clinical trial of the sulfonamides have been reported by Conant et al Marshall and Teed and others Keeney has shown that complete inhibition of the growth of C neoformans in vitro can be obtained with very high concentrations Treatment with sulfonamides should be continued for several weeks after all signs of clinical activity are gone *Cryptococcosis of the central nervous system* has a very poor prognosis No specific treatment is known Iodides in any form trivalent and pentavalent arsenicals antimony compounds thymol and gentian violet have proved ineffective *Vaccinotherapy to stimulate immunity since patients with cryptococcosis have proved to have difficulty in producing immune bodies may be given a trial* Supportive therapy should be stressed Repeated lumbar punctures may relieve symptoms Sulfonamides preferably sulfadiazine in doses sufficient to maintain a blood level of 8 to 12 mg per 100 cc of blood should be administered throughout the course of the disease and for at least two weeks after all symptoms have disappeared If the sulfonamides do not prove effective enough penicillin intramuscularly and intrathecally may be supplemented The reports as to the effectiveness of penicillin in cryptococcosis are controversial Keeney states that this drug does not inhibit the growth of C neoformans in vitro Meyer has reported that cultures of the organism are killed in vitro by penicillin Hobby and his associates have also found that C neoformans is sensitive to penicillin in vitro

CANDIDA ALBICANS (ROBIN BERKHOUT 1923)

Synonyms Monilia albicans Candida Monilia

Candida was first described *as a human pathogen by Langen*

beck in 1839 In the course of postmortem examination of a typhoid patient, he found the parasite in patches of thrush on the oral mucous membrane the pharynx and throughout the intestinal tract Charles Robin in 1843 gave to the organism the name of Oidium albicans In 1905 Castellani revealed this parasite to be a cause of bronchomoniliasis Since then,

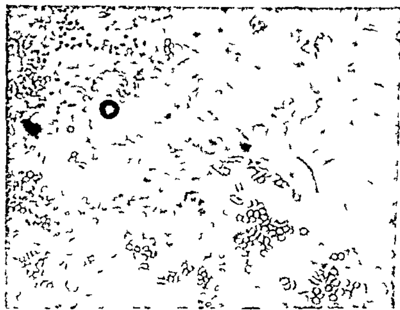


FIG 8 CANDIDA IN SCRAPINGS FROM CHRONIC PARONYCHIA AND MONILIASIS OF THE SKIN

certain diseases of the skin and other tissues have been traced to Candida albicans and other members of the species

MYCOLOGY

Candida appears in the sputum the skin, the nails, and the buccal and the vaginal mucosa as small round and oval budding yeastlike cells The sputum is examined in fresh preparation on a cover glass or smeared on a slide and given a Gram stain

Mucous patches should be placed in a drop of water or 10 per cent potassium hydroxide and examined under a cover glass Skin and nail scrapings should be examined in 10 per cent potassium hydroxide heated slightly if necessary to clear the specimen On direct microscopic examination the skin feces or sputum treated with potassium hydroxide shows numerous budding and nonbudding spores Hyphae may be present particularly in preparations from skin or nails Mycelial ele-

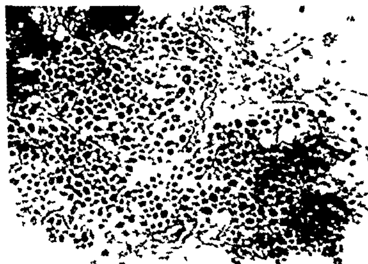


FIG 9 CANDIDA IN SCRAPINGS FROM HAIRY TONGUE (STAINED PREPARATION)

ments are seen occasionally with budding cells at the points of constriction The mycelial threads may be short and abortive or long and interwoven

On Sabouraud s glucose agar growth takes place at both room and incubator temperatures When a pure culture is obtained it may be transferred to corn meal agar in a Petri dish by cutting the surface of the agar with a small amount of

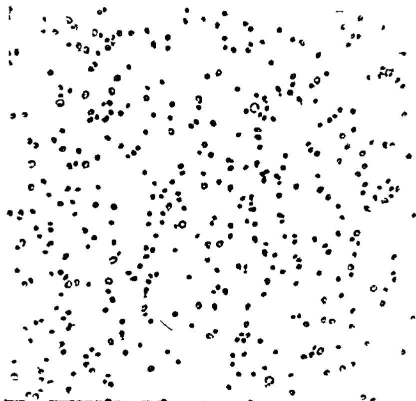


FIG 10 BUDDING AND NONBUDDING SPORES IN EARLY GROWTH OF CANDIDA ALBICANS × 600

the culture on a straight wire Examination of the streak through the bottom of the Petri dish with the low power micro scope will show chlamydospore-bearing mycelium Microscopically clusters of spores are disclosed mas ed along the hyphae Chlamydospores are present No ascospores are seen Hyphae and chlamydospores are better developed on corn meal agar than on dextrose On corn meal agar a deep stab with a needle containing the cultural growth will produce a growth *simulating an inverted pine tree This is characteristic* for this organi m

On Sabouraud's glucose broth no surface growth develops On streaked blood agar plates the colony is dull gray and of medium size Acid and gas are produced in glucose and maltose, in sucrose, acid alone



FIG 11 CLUSTERS OF SPORES AND CHLAMYDOSPORES ABOUT MYCELIUM IN CANDIDA ALBICANS X 400

ANIMAL INOCULATION

Intravenous injection of 1 cc of a 1 per cent suspension of the organism will kill a rabbit within four to five days

In some strains, positive agglutination reactions have been obtained by Benham

Only six species can be identified in freshly isolated cultures

Candida albicans
Candida tropicalis
Candida parakrusei
Candida krusei
Candida stellatoides
Candida pseudotropicalis

IMMUNOLOGIC REACTION

The cutaneous reaction is of limited diagnostic value A positive reaction is obtained in 46 to 54 per cent of patients without obvious infection, in 57 per cent of patients with localized cutaneous moniliasis, and in 52 per cent of patients with gastro intestinal moniliasis The percentage of positive reactions to the test increases in progressively older age groups Lewis and Hopper have found that 75 per cent of apparently normal persons between 51 and 60 years of age show a positive cutaneous reaction

MONILIASIS

The name moniliasis is given to a group of disorders caused by organisms belonging to the genus Candida (Monilia) Dissemination by way of the blood stream occasionally gives rise to a systemic moniliasis but the cutaneous, the mucous membrane and the visceral forms of the disease are more common

Cutaneous and Mucous Membrane Moniliasis Many forms of skin eruption formerly diagnosed as eczema, intertrigo toxic dermatitis and under the names of certain other skin disorders, are now known to be moniliasis Both a generalized and a localized form of the disease occur

Localized cutaneous moniliasis takes many forms, appearing variously as chronic paronychia, erosio interdigitalis perleche



FIG 12 CLUSTERS OF SPORES ABOUT MYCELIUM IN CANDIDA ALBICANS × 400

intra-oral thrush superficial glossitis water bath dermatitis eczema vaginitis or pruritus ani

Chronic paronychia is a common resistant condition that involves the fingers chiefly The nails show transverse ridges with eventual brownish discoloration thickening and distortion The proximal portion of the nail edge may show softening and the soft tissue about the bases and nail edges is inflamed and thickened Tenderness on pressure is another sign Chronic paronychia alone may be present or occur together



FIG 13 CHLAMYDOSPORES IN CANDIDA ALBICANS (OLD BROTH CULTURE) × 500

with erosio interdigitalis It is differentiated from onychomycosis by the absence of crumbling and yellowish discoloration, the presence of soft tissue thickening and inflammation, and the retention of nail luster Chronic paronychia affects chiefly domestics housewives bartenders, and dishwashers

Erosio interdigitalis blastomycetica is an intertrigo affecting the web between the third and fourth fingers of the hand usually the right hand The lesion has a bright red base with a moist macerated surface and a desquamating border Housewives dishwashers and domestics are chiefly affected

Perlèche, another form of intertrigo is seen in the angles of the mouth The base of the lesion is bright red the surface sometimes showing a pellicle of skin Fissures are common Some cases of perleche are said to be due to streptococcus, others to avitaminosis B

Intra oral thrush occurring anywhere in the mouth is rela



FIG 14 CANDIDA IN TISSUE × 900

tively more common in infants and children It is seen as a loosely adherent whitish membrane When removed treated with potassium hydroxide and examined microscopically it is seen to harbor a yeastlike organism

Water bath dermatitis may develop following prolonged im



FIG 15 CANDIDA ALBICANS IN LUNG ABSCESS OF RABBIT
Produced by intravenous and intrapulmonary injection with micro-organism from human bronchopulmonary moniliasis

mersion in water or continued use of wet applications of a bland nature The macerated skin, when peeled off, shows a red base Kumer and others have reported finding Monilia albicans and other yeastlike organisms in the lesions, whether these were pathogens or were living a saprophytic existence was not ascertained

Vaginitis with itching and low grade inflammation accompanied by a thin discharge may be caused by Candida albicans A whitish exudate may be superimposed on a red inflammatory base Vaginitis alone may be present or occur in combination with pruritus ani In infants it may be found with thrush

The Monilia organism however, may inhabit the vaginal region as a saprophyte

Generalized cutaneous moniliasis is less common than the localized form Occurring more frequently in children than in adults the clinical picture is characterized by perlèche and glossitis a wide-spread cutaneous eruption accompanied by inflammation and pustules and also by thinning of the hair particularly of the scalp The course of the disease is usually little affected by treatment and is frequently fatal

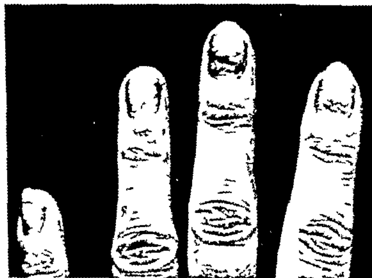


FIG 16 CHRONIC PARONYCHIA CAUSED BY CANDIDA ALBICANS

Moniliids are vesicular erythematous or exudative sterile lesions that may appear on the hands as a result of dissemination of Candida albicans through the blood stream The focus may be found elsewhere on the skin or according to Hopkins in the gastro intestinal tract

Bronchopulmonary Moniliasis Castellani (1905) first re-



FIG 17 CHRONIC PARONYCHIA CAUSED BY CANDIDA ALBICANS

ported bronchopulmonary moniliasis in Ceylon Numerous cases have since been reported from various parts of the world, especially the tropics In this country, the first case was reported from Baltimore in 1915 by Boggs and Purcoff Castellani describes the disease as occurring in a mild intermediary, or severe form, the clinical picture in each is different

The mild and intermediary types are characterized by dyspnea and cough of varying severity Hemoptysis may occur The mild type is not usually febrile, but in the intermediary

form a slight irregular rise in temperature may be noted Bodily nutrition is not markedly affected The chest signs are those of a chronic bronchitis Recovery may be spontaneous the process may remain stationary, or the disease may progress to the severe form which takes a chronic course that usually ends in death Cough expectoration and hemoptysis with hectic fever, night sweats, and emaciation characterize the terminal phase One or both lungs and frequently also the pleura may



Fig 18 Erosio Interdigitalis Blastomycetica

be involved with evidence of consolidation and pleural thickening Roentgenologic findings resemble those seen in other pulmonary infections but the more frequent involvement of the lung bases serves to differentiate the disease from tuberculosis Diagnosis can be made on the basis of direct microscopic examination of sputum and preferably bronchial secretion cultural studies animal inoculation and biochemical reactions



FIG 19 MONILIASIS OF FOOT

Treatment The treatment of moniliasis is at best, not too successful The known antibiotics and newer chemotherapeutic agents have not proved effective It is our belief that successful treatment will depend upon the discovery of agents which through either stimulation of immune reaction or direct fungistatic or fungicidal action will bring about a cure of the disease that at present is most resistant particularly in the generalized cutaneous and systemic forms



FIG 20 MONILIASIS OF CROIX

1 Gentian violet (1 per cent aqueous solution) for thrush and vesicular or pustular skin lesions Lewis reports successful use of suppositories containing 2 grains of gentian violet in cases of monilial vaginitis

2 Potassium permanganate mouth wash (1 10 000) for thrush Good results have been obtained by the author with 0 5 to 1 per cent solutions for moist cutaneous lesions

3 Sodium perborate soaks (3 drachms to ½ glass of water) for the hands and as a mouth wash in thrush Sodium perborate paste has been successfully used in chronic paronychia and in erosio interdigitalis (Greenwood and Rockwood)



FIG 21 MONILIASIS IN SUBMAMMARY AREAS

4 Mercurochrome solution (5 per cent) or the formula below This has been used successfully by the author in chronic paronychia erosio interdigitalis and the other localized forms of cutaneous moniliasis

		Gm or cc
℞	Mercurochrome crystals	0 6
	Aqua	1 2
	Acidi salicylici	2 0
	Petrolati	
	Lanolini aa ad	30 0
ℳ		

5 Fatty acids The sodium salts of propionic, valeric caprylic capric, and undecylenic acid are fungistatic and fungicidal in varying degrees for the different pathogenic fungi

when tested in vitro Of these fatty acid salts sodium caprylate is particularly effective against Candida (Monilia) albicans Keeney therefore recommends a 20 per cent aqueous solution of sodium caprylate adjusted to a reaction of pH 7 4 for the lesions in intra oral thrush Our experience with 2 cases of intra-oral thrush associated with cutaneous and onychial involvement did not parallel the results reported by Keeney However more cases need to be treated before a correct evaluation of the effectiveness of such treatment can be made

Alter et al recommend the following jelly in monilial vulvovaginitis

	Gm or cc
Calcium propionate	9 5
Sodium propionate	9 5
Propionic acid	1 0
Glycerin	10 0
Bentonite	32 0
Water	38 0

6 Iodides (orally intravenously or by inhalation) These are not usually necessary except in extensive cutaneous involvement or in the case of accompanying moniliid Ethyl iodide inhalation is the most effective measure in broncho pulmonary moniliasis systemic moniliasis and generalized moniliasis (see p 53)

7 Roentgenologic therapy in paronychia onychia and sometimes perleche An average weekly dose of 50 to 75 r unfiltered is used In our opinion this treatment is effective not because of its fungistatic and fungicidal action but because of its effect on chronic inflammatory tissue

8 Vaccine therapy This has not proved successful Successful quantitative intracutaneous therapeutic desensitization with trichophyton and monilia extracts alone and in combination have been reported by Sulzberger Wise Kerr Paicher and others Olah s attempts at autovaccine therapy in



Fig 22 Moniliasis of Knee

onychia and paronychia were unsuccessful Oidiomycin inoculations in dilutions ranging from 1 1,000 1 500 1 100 to 1 50, were used by Lewis and his co workers in a series of 48 patients, with no improvement in the majority of cases

The patient with cutaneous moniliasis must also be warned against dishwashing handling of vegetables and similar tasks without the protection of rubber or cotton gloves Intake of starchy foods should also be reduced

GENERALIZED CUTANEOUS AND SYSTEMIC TYPES

Therapy should be directed toward the eradication of all foci of infection when possible Complete study of the patient

with particular reference to diabetes nutritional disorders poor hygiene and parathyroid disease should be made X ray examination of the chest for bronchopulmonary involvement should be included

A high vitamin high calorie diet reinforced by components of vitamin B complex and liver therapy is helpful

Iodide therapy particularly ethyl iodide inhalation has proved most effective in bronchopulmonary moniliasis probably because the coefficient of distribution between the alveolar air and the blood in the lungs is sufficiently high to allow introduction of a relatively large amount of iodine into the blood



FIG 23 MONILIASIS OF MOUTH AND SKIN IN A FATAL CASE OF SYSTEMIC MONILIASIS

stream It has also been demonstrated that a small proportion is returned in the venous blood so that the tissues are exposed to relatively large amounts of iodine In bronchopulmonary moniliasis inhalation therapy is a more direct route The initial dose of ethyl iodide is 1 5 cc (3 Gm) This is increased by 0 5 cc (1 Gm) per dose until 4 cc (8 Gm) is reached

This may be given in one or in divided doses Treatment is given on two successive days and skipped on the third day to avoid cumulative effect A mineral oil spray to avoid irritation of the throat may be used once or twice a day The inhaler of choice* is designed to allow a comfortable mixture of ethyl iodide and air to be inhaled It is important that the ethyl iodide be free from impurities particularly phosphorus † This can be accomplished by proper distillation *Ethyl iodide*



Fig 24 Moniliasis of Mucous Membrane of Mouth in Fatal Case

should never be administered to patients suffering from pulmonary tuberculosis toxic goiter or nephritis The number of treatments varies with the site of the infection its duration, and the nature of the invading organism Infections caused by the yeastlike fungi are relatively more resistant to treatment

* The inhaler may be obtained from Warren Collins Boston Massachusetts

† Purified ethyl iodide may be obtained from Burnham Soluble Iodine Company Auburndale Massachusetts

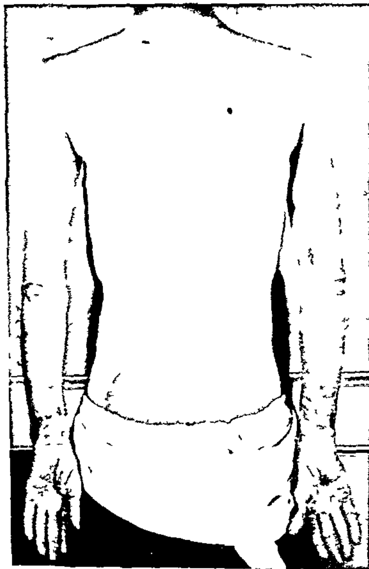


FIG 20 GENERALIZED MONILIASIS (Fatal Case)

The most common complication is the acneform eruption, on the face and upper trunk The eruption usually disappears a few days after the drug has been discontinued Treatment may be resumed without ill effect in most cases A vesicular, bullous eruption should be a signal to discontinue the drug Peripheral neuritis is a rare complication and is probably due



FIG 26 BRONCHOPULMONARY MONILIASIS
(Courtesy of I B D Neuhauser and A Tucker)

to the ethyl radical Treatment with ethyl iodide should be discontinued when peripheral neuritis occurs

Other forms of iodine therapy may be used Saturated solution of potassium iodide starting with 15 drops three times a day orally and increased 3 drops daily to the point of toler ance is most commonly administered Sodium iodide intra-

venously in 1 Gm daily doses may be used Tincture of iodine in milk or water may be given orally, starting with 5 drops three times a day and increasing the dose to the point of tolerance

Martin and Smith recommend desensitization with monilial vaccine in hypersensitive patients before any course of iodine therapy is started (see discussion on treatment of blastomycosis, p 152)

Hiat and Martin describe a dramatic recovery in a case of bronchopulmonary moniliasis treated with anti *Candida albicans* rabbit serum The patient was given injections subcutaneously, beginning with 0 1 cc of a 1 10 dilution and the dose increased by 0 1 cc daily until 0 9 cc was reached This favorable response was obtained in a patient with negative skin test to Candida albicans vaccine a negative complement fixation test and a positive immediate reaction to an anti *Candida albicans* rabbit serum Our experience with this form of treatment is limited to two cases of generalized cutaneous moniliasis We did not obtain the good results reported by Hiat and Martin More cases need to be treated before proper evaluation can be made

One of the authors (J H S) is using blood serum from patients recovered from localized moniliasis such as chronic paronychia in the treatment of systemic moniliasis The results will be reported later

Pityrosporum Ovale

This is a yeastlike organism originally described by Malassez in 1874 It is also known as the bottle bacillus MacLeod and Dowling in 1928 succeeded in cultivating it but could not keep transplants alive Previously Unna Engman Castellani Templeton and others had had similar experience Moore recently reported success in approximately 10 per cent of cases by culturing the organism on wort agar (Difco), and also succeeded in inoculating it on other media from a good



FIG 27 PITYROSPORUM OVALE IN SCALE STAINED WITH METHYLENE BLUE × 1100
(Courtesy of Rhoda Benham)

primary growth on the wort The following medium is recommended by Lewis and Hopper for subculture when it is desired to keep the growth alive

	Gm or cc
Technical maltose	20 0
Technical dextrose	20 0
Peptone	10 0
Agar agar	18 0
Distilled water	1 000 0



FIG 28 PITYROSPORUM OVALE
Culture on wort agar and ether extract of oleic acid × 00 (Courtesy of Rhoda Benham)

Benham recommends the addition of butter since she has shown that Pityrosporum ovale requires a fatty environment

The colonies vary in color from a light ochraceous salmon to pinkish buff At the end of forty days the culture measures 2 cm The individual cells as seen on culture mounts are bottle shaped and vary in size from 3 to 15 microns in diameter According to Moore Keil Engman and Engman inoculation of animal and human subjects with the organism from their culture which they called P ovale produces a clinical and pathologic picture simulating seborrheic dermatitis Their findings still await confirmation In a survey of scalps of 100 patients MacKee Lewis Spence and Hopper found Pityrosporum ovale on 70 per cent normal scalps and on 66 per cent

of scalps on which there was a concomitant skin disease In the majority of examinations, it was found that there was a greater number of colonies grown from scalps with dandruff than from normal scalps They also found that Pityrosporum ovale is also a common inhabitant of the skin

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CHAPTER IV

GENUS MICROSPORUM (GRUBY, 1843)

Of the numerous species of Microsporum only three will concern us here

Microsporum audouini (human type)
Microsporum canis (lanosum) } (*animal type*)
Microsporum gypseum (fulvum) }

The other species of this genus, in the authors opinion, hardly merit discussion since they are either rare or in all probability identical with these three

Mycology

Generally parasitic in the hairs and the hair follicles, Microsporum may also attack glabrous skin M canis (lanosum) has been isolated in several cases of dermatophytosis of the hands and feet In the lesions can be seen mycelial filaments and small roundish spores from 2 to 3 microns in diameter sometimes arranged in a mosaic pattern

These organisms are easily cultivated on Sabouraud's or other sugar media Sprouting with branching mycelium and spore-bearing hyphae may be observed The hyphae show oval conidia from 3 to 4 microns long and from 2 to 3 microns wide, sessile or attached to short sterigmas These conidia do not as in the genus Trichophyton appear *en grappe* Terminal, septate or nonseptate spindles called *fuseaux*, and appearing as large fusiform structures from 30 to 60 microns long and from 15 to 18 microns wide with granular contents are present At the apex can be seen peculiar hairlike formations (see definitions, p 4) Chlamydospores usually make their appearance under unfavorable conditions taking the form of large double-contoured cells from 18 to 22 microns



FIG 29 SPORES AND MYCELIUM IN POTASSIUM HYDROXIDE PREPARATION OF HAIR IN TINEA CAPITIS

long and from 6 to 8 microns wide that contain granular protoplasm There are also denticulate or pectinate bodies—curved mycelial segments showing on the convex side several small protruding processes *Pleomorphism* the process by which a culture loses its distinctive characteristics and becomes unrecognizable is more characteristic of the animal species

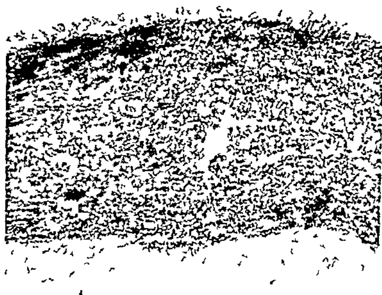


FIG 30 HAIR INFECTED WITH MICROSPORUM SHOWING SPORES × 150

(i e , M canis M fulvum) than of the human species (M audouini)

MICROSPORUM AUDOUINI (GRUBY 1843)

On Sabouraud s dextrose medium colonies are close and matted, showing after three weeks growth some radiating furrows On polished rice the only evidence of growth is a brownish discoloration of the medium Conidiophores of varying lengths, *simple at first and later occasionally showing* a few branches, can be seen Fuseaux vary in length from 31 to 82 microns and are anywhere from 8 to 14 microns wide

the average length is 70 microns, the average width 12 microns The shape of these tapers toward a slender outer end and a truncate base, their surfaces show numerous blunt tipped spinous protrusions that under the microscope appear hyaline to light yellow The microconidia are pyriform measuring *from 2 to 5 microns in length and from 1 5 to 2 microns in width*

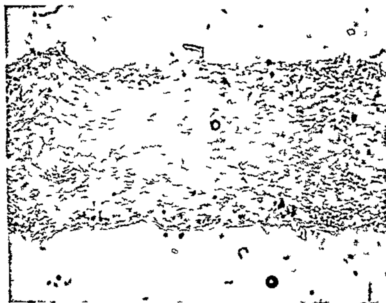


FIG 31 SPORES AND MYCELIA IN POTASSIUM HYDROXIDE PREPARATION OF HAIR IN TINEA CAPITIS CAUSED BY MICROSPORUM × 200

they are single celled sessile or attached to short sterigmas and pleurogenous Nodular bodies in great numbers can be found inclosed in twisted knotted hyphal strands Pectinate hyphae are long recurved and locally expanded on the outer surfaces Chlamydospores are borne both terminally and intercalarally in the submatrical hyphae Racquet hyphae

are numerous everywhere In the size and general characteristics of its fuseaux, this species closely resembles M canis (lanosum)

On polished rice, no aerial mycelium is produced by M audouini and, as already stated, growth is evident only as a progressive brownish discoloration of the medium, whereas an

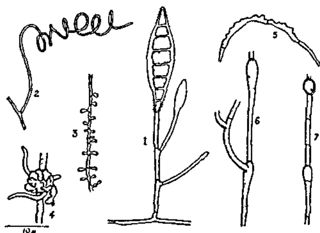


FIG 32 REPRESENTATIVE STRUCTURES IN GENUS MICROSPORUM

1 *Mature macroconidium (fuseau) seen in optical section (immature macroconidium begins as swelling at apex of side branch)* 2 Spiral hyphae 3 Laterally borne microconidia 4 Nodular body 5 Pectinate hypha 6 Racquet hypha 7 Chlamydospore *thick walled resting spore* Spirals exceptionally rare

abundant growth of aerial mycelium and numerous fuseaux characterize M canis Also, whereas M audouini is clear and mouse gray throughout after ten days' growth on Sabouraud's medium M canis under the same circumstances appears under filtered ultraviolet rays to have a lavender blue, shell-pink, or flesh-ochre center with a lavender blue midzone (not always present), and an olive drab or mouse gray edge

Microsporum Canis (Bodin 1902)

Synonym Microsporum lanosum (Sabouraud 1907)

On Sabouraud s agar the growth at first differs from M au douini only in its greater abundance and downiness From twenty five to thirty days after inoculation the central portion becomes umbilicated a ring of snow white duvet surrounding the depression in old cultures the ring may become yellowish Microscopic examination shows spore-bearing hyphae with conidia from 3 to 4 microns long and from 2 to 3 microns wide and not supported by short sterigmas in contrast with those of the genus Trichophyton Fuseaux are found usually at the ends of certain filaments and measuring from 30 to 60 microns in length and from 15 to 18 microns in width they are spindle-shaped usually septate and have granular contents At the apex are some peculiar hairlike formations not observed in the spindle of Trichophyton Chlamydospores from 18 to 22 microns long and from 6 to 8 microns wide with protoplasm that is usually granular and membrane that may be double-contoured are generally found under poor conditions of growth There are also denticulate or pectinate bodies generally curved mycelial segments with one side usually the convex showing small protruding processes

Two week-old colonies on rice are matted or cottony and white to pinkish buff later becoming powdery with a pinkish buff to citron yellow discoloration of the substratum The conidiophores are at first simple and measure from 40 to 70 microns in length the terminal conidiophores are more elongated and up to 190 microns long Later these give rise by lateral ascending branching to shorter conidiophores that are hyaline and slender swell gradually to the bases of the fuseaux and sometimes reach dimensions of from 54 to 94 microns in length and from 14 to 22 microns in width The microconidia are pyriform sessile or have short sterigmas and have a length of from 3 to 5 microns and a width of from 1 5 to 2 microns

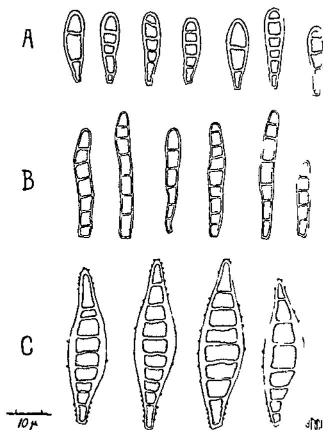


FIG 33 TYPES OF FUSEAUX (MACROCONIDIA)

A Club-shaped fuseaux of Epidermophyton
B Long tapering fuseaux of Trichophyton
C Thick walled spindle-shaped multiseptate spiny fuseaux of Microsporum

Pectinate and spiralled hyphae are present and racquet mycelium in abundance This species differs from the others of the genus Microsporum in the extreme size of its fuseaux

On Sabouraud s medium the 10 day-old culture appears under filtered ultraviolet rays to have a lavender blue shell

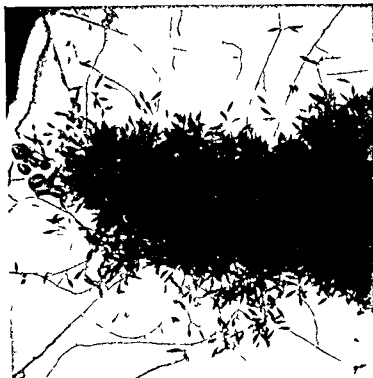


FIG 34 MICROSPORUM CANIS (LANOSUM)
Hanging-drop preparation showing fuseaux (macroconidia) at low magnification

pink or flesh ochre center a lavender blue midzone (not always present) and an olive drab or mouse gray edge

MICROSPORUM GYPSEUM

Synonym Microsporum fulvum

On Sabouraud s medium the growth of this species is luxuriant and rapid A central boss is seen surrounded by a brownish powdery ring The color may vary from cinnamon brown to a lighter shade of brown almost to pink An interest

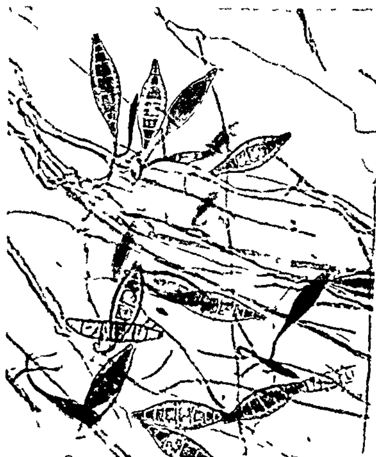


Fig 35 Microsporum Canis (Lanosum)
Culture mount showing spindle fuseaux (macroconidia) × 500

ing feature is the variation in color to the point of complete loss of color in transplants of the same strain White duvet covers the peripheral zone of the colony Microscopically truncate elongated fuseaux are seen as well as pectinate hyphae and nodular bodies On polished rice the colonies at first show a white cottony growth, the mycelium later becoming



FIG 30 MICROSPORUM FULVUM (Culp um)
Culture mount showing fuseaux (macroconidia)

matted and powdery with pale ochraceous buff areas The substratum is discolored to a pinkish buff At first relatively simple the conidiophores later become multibranched the branches arising at right angles The primary conidiophores may reach a length of 130 microns the secondary conidiophores may be from 12 to 49 microns long and from 2 to 35 microns wide becoming slightly expanded toward the apex The fuseaux which measure from 28 to 56 microns in length and from 8 to 14 microns in width are elongate their bases are ellipsoid and truncate The fuseau wall is thin and the surface shows numerous wartlike projections The microconidia which are from 3 5 to 5 5 microns long and from 2 to 3 5 microns

wide are sessile or grow on short slender sterigmas Spiralled hyphae and chlamydospores are present

Tinea Capitis

CLINICAL MANIFESTATIONS

Tinea capitis is caused by various species of fungous parasites, chiefly by the Microsporum group, sometimes by certain of the Trichophyton species—T violaceum, T crateriforme, T gypseum, and T sulfureum Chiefly a disease of childhood, it rarely attacks adults Microsporum canis (lanosum) and M audouini are the two chief causative agents, the former is the most frequently encountered on the Atlantic seaboard

Tables 1, 2 and 3 represent the incidence of species of Fungus and the sex incidence among 288 cases of tinea capitis in our series recently reported in the Archives of Dermatology and Syphilology

Table 1 —*Incidence of Species of Fungus*

Species	No of Cases	Percentage
Microsporum canis	188	65 3
Microsporum audouini	73	25 4
Microsporum fulvum	2	0 7
Trichophyton schoenleini	22	7 6
Trichophyton gypseum	2	0 7
Trichophyton sulfureum	1	0 3

Table 2 —*Distribution of Cases According to Sex (exclusive of favus)*

Sex	No of Cases	Percentage
Males	165	62
Females	101	38

Table 3 —*Sex Incidence in Relation to Fungus Species in [illegible] Cases*

Sex	No of Cases	M audouini	M canis
Male	156	55 (75%)	101 ([illegible]%)
Female	100	18 (25%)	82 (45%)

The clinical picture of tinea capitis and the course of the disease varies with the infecting micro-organism *Inflammatory* reaction usually accompanies tinea capitis caused by M canis



FIG 37 TINEA CAPITIS CAUSED BY MICROSPORUM CANIS (LANO TM)

M fulvum T violaceum T crateriforme T gypseum and T sulfureum Tinea capitis caused by M audouini is usually noninflammatory in nature The black dot appearance is usually associated with T violaceum

Microsporum audouini This micro organism produces the noninflammatory type of ringworm of the scalp commonly known as the gray patch The patches show broken off dull hairs covered with a grayish sheath The surface of the patch is usually scaly with little or no inflammation The in

wide are sessile or grow on short slender sterigmas Spiralled hyphae and chlamydospores are present

Tinea Capitis

Clinical Manifestations

Tinea capitis is caused by various species of fungous parasites, chiefly by the Microsporum group, sometimes by certain of the Trichophyton species—T violaceum, T crateriforme, T gypseum, and T sulfureum Chiefly a disease of childhood, it rarely attacks adults Microsporum canis (lanosum) and M audouini are the two chief causative agents, the former is the most frequently encountered on the Atlantic seaboard

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Sex	No of Cases	Percentage
Males	165	62
Females	101	38

Table 3 —*Sex Incidence in Relation to Fungus Species in 256 Cases*

Sex	No of Cases	M audouini	M canis
Male	156	55 (75%)	101 (55%)
Female	100	18 (25%)	82 (45%)

The clinical picture of tinea capitis and the course of the disease varies with the infecting micro organism Inflammatory reaction usually accompanies tinea capitis caused by M canis



FIG 39 TINEA CAPITIS CAUSED BY MICROSPORUM FULVUM (GYPSEUM)

are common Resistance to treatment is a common experience The intracutaneous test with trichophytin shows either a slight or no reaction

Microsporum canis (*lanosum*) As a rule there is accompanying inflammation varying in degree However at times the clinical appearance of the patches in the scalp is indistinguishable from those in tinea capitis caused by M audouini Kerion formation occurs in about 3 to 5 per cent of cases Glabrous skin involvement is common Sensitization of the skin with resulting id eruption occurs The intracutaneous test with trichophytin usually results in a moderate to vigorous reaction

Microsporum gypseum (*fulvum*) The scalp lesion produced is usually inflammatory and there is a tendency for the infec



FIG 38 TINEA CAPITIS CAUSED BY MICROSPORUM AUDOUINI

fection usually begins as a small patch in the occipital and temporal regions These patches enlarge in size and number to become scattered throughout the scalp In general the picture of extensive tinea capitis is that of a wheat field devastated by a tornado, with broken stalks bent or uprooted There are rarely any lesions found on the glabrous skin either as a result of spread of the infection or cutaneous sensitization known as 'id' reaction Epidemics in orphanages and other institutions

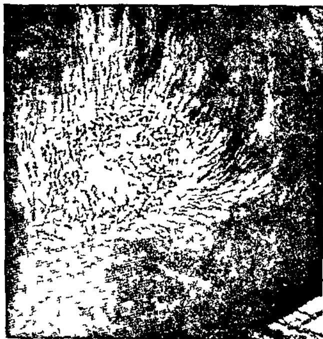


FIG 41 TINEA CAPITIS CAUSED BY TRICHOPHYTON

to 40 per cent sodium or potassium hydroxide is added The cover glass is then put in place the preparation heated gently to the bubbling point thinned by slight pressure on the cover glass and allowed to stand for ten or fifteen minutes to clear The microscopic field will reveal the presence of numerous small hyalin like spores Some of these forced out by the pressure used in thinning the preparation may be seen elsewhere than on the hairs The field is best examined first with the low power lens usually used for high dry microscopic examination Use of the Swartz Conant stain or the counter stain (see pp 16–17) is advised for a permanent preparation and for better study of the spore structure For culture study some of the hairs should be planted on Sabouraud's



FIG 40 TINEA CAPITIS AFTER X RAY EPILATION

tion to remain localized Kerion is common Glabrous skin involvement is usual, producing typical lesions of tinea circinata with or without pustulation Cutaneous sensitization with 'id' reaction may be present The reaction to an intracutaneous test with trichophytin is usually vigorous

Hair stumps make the best material for microscopic study These show the presence of the organism while scales usually do not For direct microscopic examination a few of the broken off hairs are placed on a slide and a drop or two of 20

Microscopically, the contents of the lesion or of the hairs within the infected area show the presence of various sized spores and some branching hyphae. The lesion is sometimes mistaken for a carbuncle, but the latter condition is more painful and its existence is absolutely ruled out by the microscopic examination. The hair or the gelatinous fluid or both are

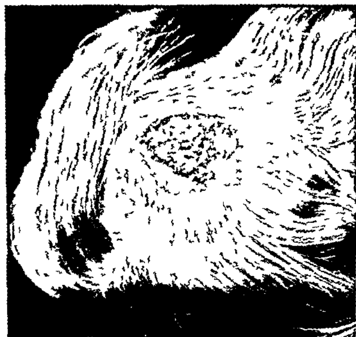


FIG. 42. KERION CELSI OF SCALP CAUSED BY M. CANIS

placed on a slide, treated with 20 to 40 per cent sodium or potassium hydroxide, covered with a cover glass, heated gently to bubbling, thinned, and allowed to clear. In the fluid and hairs numerous spores of varying size with branching septate hyphae are seen. The culture is prepared as in the case of tinea capitis.

media For cytologic studies, polished rice and other grain media may be used To avoid pleomorphism and to preserve the culture for a long period, conservation media must be used (see p 20)

Examination with a Wood filter for fluorescence aids in picking out infected hairs for microscopic examination (for technic, see p 25)

Microsporid As a result of cutaneous sensitization to the causative organism or to spread of its breakdown products by the hematogenous route from an inflammatory focus of the scalp, skin eruptions may appear The eruption may be folliculo-papular, may simulate lichen scrofulosorum, may appear in groups of minute pustules or may be scaly The eruption is usually found on the face upper trunk, and extremities The distribution is symmetrical The lesions are void of fungi Microsporid eruptions may be noted particularly following roentgen ray epilation or very active treatment "Id" reaction is rare in noninflammatory lesions of the scalp and most commonly accompanies frank kerion

Kerion Celsi

CLINICAL MANIFESTATIONS

This suppurative lesion usually caused by M lanosum, M fulvum T violaceum T crateriforme, T gypseum has also been reported as caused by M audouini It is common in children

The signs are loss of hair, inflammation edema, bogginess and a carbuncle-like tumor discharging a mucoid or mucopurulent secretion Tenderness may be present but is usually absent The size of the involved area may vary from that of a small bean to more than that of a walnut Cutaneous sensitivity as manifested by an id reaction is frequently present The trichophytin test usually shows a moderate to vigorous reaction except in cases of infection caused by T violaceum when the reaction is negative

ment are few and small, or when roentgen ray epilation is not possible A demonstration by the doctor or nurse showing proper epilatory technic and how to avoid spreading the infection by taking care to collect the hairs on some article that can be burned is advisable Epilation should be a daily procedure One of the following fungicidal preparations should always be applied immediately afterward

		Gm or cc
℞	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0
ℳ		
℞	Phenoli	4 0
	Camphoris	4 0
	Iodini	4 0
ℳ		
℞	Sulphuris sublimatis	4 0
	Phenolis	4 0
	Naphtholis	? 0
	Cerae albae	1? 0
	Adipis	?0 0
ℳ		

Potassium permanganate solution (1 per cent) may be painted on twice a day The child should wear a boilable inner cap that will cover the entire hairy region of the scalp and this should be changed and boiled at least once a day If the iodine solution produces a dermatitis use of it should be suspended until the reaction disappears

Sodium propionate solution may be applied mornings and sodium propionate ointment at night

	Gm or cc
Sodium propionate	12 3
Propionic acid	2 7

(Continued on next page)

Sodium propionate solution powder and ointment may be obtained from the Mycoloid Laboratories Inc Little Falls New Jersey



Fig 43 Kerion Celsi of Scalp Caused by M Canis

Treatment

Treatment of tinea capitis depends a great deal upon the causative fungus In general, infections caused by fungi which are also pathogenic to animals respond better to treatment, and often cure spontaneously Infections caused by M audouini and by the trichophyton (endothrix) are resistant to treatment and rarely cure spontaneously Rothman and his co-workers demonstrated that the spontaneous cure of infections caused by M audouini and the immunity of adult scalps are due to the presence in the sebum of adults of a higher concentration of saturated fatty acids with selective fungistatic and fungicidal action

Since the infection is within the hair treatment should be aimed at removal of infected hairs either by manual or by roentgen ray epilation or by epilation with thallium acetate For *manual epilation* a forceps is used to pluck out the infected hairs or they are stripped out by means of adhesive tape These measures are practicable only when the areas of involve-



FIG 44 TINEA CIRCINATA

such instances every other mode of therapy should be resorted to before thallium acetate is administered Thallium acetate is contraindicated in patients with renal impairment The drug is administered orally in a single dose of 8 mg dissolved in sweetened water per kilogram of body weight The weight

Sodium caprylate	10 0
Zinc caprylate	5 0
Dioctyl sodium sulfo uccinate	0 1
Carbowax 4000	69 9

Schwartz reports good results with the use of the following formulae in tinea capitis due to M audouini

		Gm or cc
1	Salicylanilide	5 0
	Hyamine 1622 (25 per cent)	5 0
	Carbowax 1500	100 0
2	S S copper undecylenate in carbowax 1 500	
3	Pentachlorophenol	1 0
	Carbowax 1500	100 0

Roentgen ray epilation has proved very useful in the treatment of the resistant forms of tinea capitis This method of treatment is a most delicate procedure requiring considerable patience, special training, and skill It can be dangerous in the hands of the inexperienced since the margin of safety between temporary and permanent epilation is narrow It can be used only with patients old enough to remain absolutely still during treatment The physician must make certain that no stimulating or irritating drug nor photo active substance has been used for at least ten days prior to the exposure to the rays The necessary local after treatment may be initiated two weeks after irradiation The reader is referred to Chapter XXVII in MacKee and Cipollaro s textbook, ' X rays and Radium in the Treatment of Diseases of the Skin ' for the exact details on technic

Thalium acetate is a highly toxic drug A mistake in the dose of this drug may result in the death of the patient Several reports of death due to the use of the drug have appeared in the literature The authors do not recommend its use except in case of an epidemic in an institution for feeble minded where epilation by x ray is neither possible nor practical Even in

tion and cultural studies The viability of the micro organism in questionable hairs is best determined by cultural studies A final inspection one month later is advisable

TABLE 4.—*Cases Requiring X Ray Epilation (exclusive of favus) in Our Series of 266 Cases*

Organism	No. of Cases	Percentage
M canis	22	37 3
M audouini	32	54 2
Trichophyton	1	1 7
Unidentified	4	6 8

TINEA CIRCINATA

CLINICAL MANIFESTATIONS

This disease may be caused by either the Microsporum or the Trichophyton family

Tinea circinata is a superficial fungus infection characterized by the presence of superficial circinate lesions with clearing centers The border is composed of minute vesicles that soon dry up to form minute crusts and scales At times there is formation of various figures such as figures-of-eight or iris shaped lesions The face neck and upper extremities are the most common locations although any part may become involved

This disease is sometimes confused with impetigo contagiosa and the herald spot of pityriasis rosea

The presence of branching septate mycelia in the scales from the lesion when examined after being prepared with potassium hydroxide rules out the other possibilities

TREATMENT

The sources of infection should be sought out—such as a pet animal or another child—and treated

Local treatment consists of thorough cleansing boiling of



Fig 45 Tinea Circinata

of both the child and the drug should always be rechecked by a competent person

Ethyl iodide inhalations combined with local treatment and manual epilation may be used in cases in which the causative organism *is M audouini and in which x ray epilation is not* practical At least three successive weekly negative examinations of the scalp under the filtered ultraviolet rays should be obtained before the patient is discharged as cured Any questionable hairs should be checked by direct microscopic examina

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clothing that comes in contact with infected areas, and application twice a day of 2 per cent gentian violet or the following ointment

		Gm or cc
℞	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0

M

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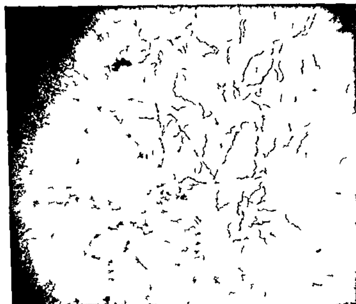


FIG 46 POTASSIUM HYDROXIDE PREPARATION OF SKIN SCALES ROOFS OF VESICLES OR NAIL SCRAPING SHOWING BRANCHING MYCELIUM × 155

Trichophyton sabouraudi (Blanchard 1895)
Variants
Trichophyton acuminatum Trichophyton pilosum

Trichophyton sulfureum (Sabouraud 1910)

Trichophyton schoenleini (Langeron and Milochevitch 1930)
Synonym
Achorion schoenleini

In hairy regions characteristically the scalp or beard this group of fungi produces ringworm In glabrous skin tinea circinata and dermatophytosis develop Onychomycosis is another possibility Although in some instances characteristic lesions are produced it is not possible as a rule to make a diag

CHAPTER V

GENUS TRICHOPHYTON

THE GENUS Trichophyton* includes a large number of species, some of them very rare. For the purposes of this text of condensed scope only those most frequently encountered are singled out for discussion here. These include:

Trichophyton mentagrophytes (Robin, Blanchard, 1895)

Variants

Trichophyton gypseum
Trichophyton granulosum
Trichophyton asteroides
Trichophyton radiolatum
Trichophyton felineum
Trichophyton interdigitale
Trichophyton farinulentum
Trichophyton lacticolor
Trichophyton persicolor

Trichophyton rubrum (Castellani, Sabouraud, 1911)

Variant

Trichophyton purpureum (Bang)

Trichophyton megnini (Blanchard, 1895)

Variants

Trichophyton roseum
Trichophyton rosaceum

Trichophyton violaceum (Sabouraud, 1902)

Variants

Trichophyton violaceum
Trichophyton glabrum

Trichophyton tonsurans (Malmsten, 1845)

Variant

Trichophyton crateriforme

* In the terminology used in this chapter the prefixes ecto-, mega-, endo- and neoendo- often used to qualify the term Trichophyton have been omitted since use of these merely complicates exposition.



FIG 48 LOW POWER PREPARATION DEMONSTRATING BEADED SEPTATE MYCELIUM IN SCALE FROM DERMATOMYCOSIS
Lactophenol cotton blue stain × 400

and many of those causing sycosis and dermatophytosis The parasite is common in the United States among French German and Hungarian agricultural laborers but has been found also in São Paulo Brazil in Uruguay in Tomsk Siberia and in Japan It is one of the chief fungi causing dermatophytosis of the feet intertrigenous infections and infections of the nails It has been found on horses and is pathogenic in guinea pigs

MYCOLOGY

The organism can be recovered from lesions of the glabrous skin scalp and beard Growth is rapid Colonies are characteristically powdery, in rare instances they are velvety The

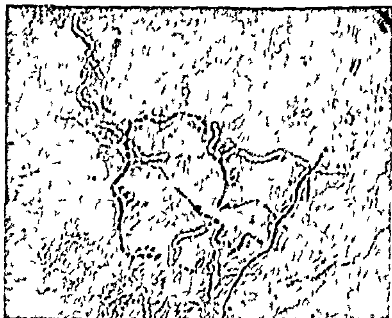


FIG 47 DIRECT MICROSCOPIC EXAMINATION OF SKIN SCALES LOOPS OF VESICLES AND NAIL SCRAPINGS SHOWING SEPTATE AND NONSEPTATE MYCELIUM × 500

nosis of the fungus species concerned on the basis of the clinical findings cultural and morphologic studies are necessary

The organisms are easily cultivated on Sabouraud s medium or other sugar media The culture shows branching mycelium spore-bearing hyphae conidia attached singly or appearing *en grappe* and multiseptate tapering thin walled fuseaux (macro conidia) The last named are usually found less frequently than in the genus Microsporum and sometimes require special media, such as polished rice or other grain media to bring them out Spirals are present particularly in T gypseum Unfavorable conditions usually give rise to chlamydospores

TRICHOPHYTON GYPSEUM (BODIN, 1902)

This species includes most of the kerion producing organisms



FIG 50 ACTIVE AND DEGENERATED MYCELIUM POTASSIUM HYDROXIDE PREPARATION OF SKIN SCALE ROOFS OF VESICLES OR NAIL SCRAPINGS × 500

A reaction to an intracutaneous test with trichophytin can be elicited Lewis and Hopper feel that the powdery type sensitizes the skin to a greater degree than the fluffy type

TRICHOPHYTON INTERDIGITALE

This micro organism is considered to be a variant of T gypseum and causes intertrigenous infections of the feet It is common in Austria Germany United States Spain Argentina São Paulo and Brazil

MYCOLOGY

On Sabouraud s agar the rate of growth is fast beginning as a downy feather like projection and within two weeks almost covers the entire agar slant as a white fluffy growth On

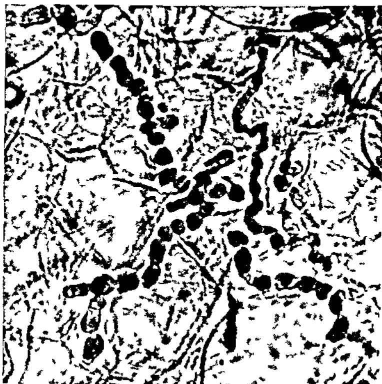


Fig 49 Mycelia in Scales from Dermatomycosis Stained Preparation
× 700

central deeply furrowed cupola, with rudimentary, spearlike rays and a white powdery disk is distinctive On Sabouraud's glucose agar the round domed center, marked by powdery rays, later becomes umbilicate with multiplying lanceolate rays that appear to be dusted with a white powder where they reach the surface of the medium The reverse side of the medium is reddish in color Pleomorphism occurs in four or five weeks On Sabouraud's conservation agar, the surface resembles irregular lunar craters and appears powdered though *more* lightly, as on carbohydrate media

Cutaneous sensitivity with resulting "id" reaction does occur

MYCOLOGY

On Sabouraud's agar, the colony is powdery and shows a yellowish white disk with a scattering of granules its center having a raised crater or radial folds that are sometimes half-hooded On conservation agar the central portion is smaller the denticulate margin larger, and the surface often dewy



Fig 52 Mosaic Structures × 500

Trichophyton Felineum

Probably a variant of T gypseum this organism attacks chiefly glabrous skin It is reported from France Germany Switzerland Austria and Japan

MYCOLOGY

Cultures on Sabouraud's glucose or maltose agar produce a pure white velvety colony having a crater like center from

culture mount vegetative filaments, microconidia en grappe, nodular bodies and racquet mycelium are found Spirals and fuseaux are difficult to demonstrate The fuseaux may be demonstrated when grown on grain media, particularly rice



FIG 51 MYCELIA AND MOSAIC STRUCTURE IN SCALES × 500

TRICHOPHYTON GRANULOSUM

This organism is looked upon as a varient of T gypseum A cause of scalp kerion and beard ringworm T granulosum, has been reported from Poland, Manchuria Japan, and São Paulo, Brazil



FIG 54 ARTEFACTS PRODUCED BY GLYCERIN AND POTASSIUM HYDROXIDE SIMULATING MOSAIC STRUCTURES × 400

TRICHOPHYTON RUBRUM

This organism attacks glabrous skin chiefly but it has been found in lesions of onychomycosis and tinea sycosis as well Ota has disclosed it to be a frequent cause of tinea cruris in Japan and Manchuria Weidman states that it is common in the South where cases diagnosed as eczema marginatum onychomycosis and dermatitis were shown by Hodges to be actually due to T rubrum Lewis Montgomery and Hopper

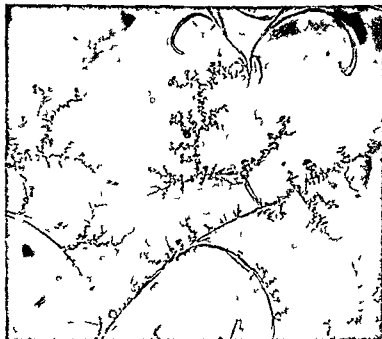


FIG 53 ARTEFACTS POTASSIUM HYDROXIDE CRYSTALS × 200

which long slender delicate rays fan out Pleomorphism does not occur

TRICHOPHYTON LACTICOLOR

A cause of tinea sycosis this organism has been reported from France, Germany Sweden Hungary Japan from São Paulo in Brazil, and from the state of New York

MYCOLOGY

On culture the butter colored colonies show flat disks cut by shallow radial grooves The surface suggests hot curdled milk On conservation media, the colony takes the shape of a truncated cone, with furrows spreading from an extremely deep central depression The surface is velvety



FIG 56 SPIRAL IN T GYPSEUM (HANGING DROP PREPARATION) × 700

Cutaneous sensitivity with resulting "id" reaction is rare A reaction to an intracutaneous test with trichophytin is usually slight or absent

TRICHOPHYTON MEGNINI (BLANCHARD 1895)

Variants Trichophyton roseum (Bodin) Trichophyton rosaceum (Sabouraud)

This species causes tinea of the beard in man and attacks animals as well It is common in the north of England and endemic in France Belgium the Netherlands Denmark, and



FIG 55 MYCELIUM AND LINEAR CRACKS IN COVER SLIP × 500

found this parasite in dermatoses simulating arsenical keratosis, neurodermatitis eczema, sycosis vulgaris and erythema annulare centrifugum The author (J H S) and Conant reported 4 cases of extensive lichenified dermatitis due to T rubrum

MYCOLOGY

On Sabouraud s dextrose agar, growth begins in from four to six days In about seven days a reddish purple pigmentation appears this being especially noticeable on the reverse side After ten days there develops in the center of the colony an aerial mycelium which gives way to a powdery type of growth At first white it deepens to pink in the 3 week-old culture In subcultures the purplish hue tends to fade out

Microscopic examination reveals the presence of aleurospores, both single and clustered chlamydospores fuseaux (macroconidia), spirals and an occasional nodular body



FIG 58 NODULAR BODIES IN CULTURE MOUNT FROM GENUS TRICHOPHYTON × 500

France and has been reported in regions from Palestine to Algeria and parts of the Sudan In the United States the organism is chiefly found in immigrants Only sporadic cases have been noted in American born It is inoculable in guinea pigs dogs and cats

MYCOLOGY

The colony fades from an initial violet to grayish white and



Fig. 57 Spirals in Culture Mount of T. Gypseum × 500

Germany It is occasionally encountered in Italy and on the American continent in the cities of Montreal and Philadelphia It is seen rarely in Japan and São Paulo Brazil It is transmissible to guinea pigs and dogs

MYCOLOGY

On culture the colony gradually changes in color from a velvety pure white to pale rose with the reverse side taking on a gooseberry violet hue On Sabouraud's conservation agar the surface is snow white and the underside black Pleomorphism occurs

Trichophyton Violaceum (Sabouraud apud Bodin, 1902)

Producing tinea capitis, tinea circinata onychomycosis, and sycosis, this organism is found in Russia, Poland and

Trichophyton Tonsurans (Malmsten 1845)

Variant Trichophyton crateriforme

This organism produces tinea capitis and is the most common species of Trichophyton found in the city of Paris it is widespread in western Europe It is inoculable in guinea pigs

MYCOLOGY

The colony is white and velvety, with a yellowish buttony center being crateriform in shape Later it becomes powdery Pleomorphism is not common Microscopically one sees aleurospores that may appear both laterally and in thyrses and show hyphal tips that are often clavate these aleurospores are sometimes sessile Transitional forms ranging down to small chlamydospores may be seen

The reaction to an intracutaneous test with trichophytin elicits a vigorous response

Trichophyton Sabouraudi

Variant Trichophyton acuminatum

This organism which causes tinea capitis is widespread in Europe It is inoculable in guinea pigs

MYCOLOGY

As the colony ages it changes from a small hemispherical mass to a white then creamy finally brownish and sometimes violet tinted flattened cone that has furrows of varying depth radiating from the center and a thin flat margin Pleomorphism is rare Microscopically one finds lateral or grouped aleurospores and swellings on the hyphae that suggest young chlamydospores

Trichophyton Sulfureum (Sabouraud 1910)

This is common in England and Australia producing tinea capitis and lesions on glabrous skin

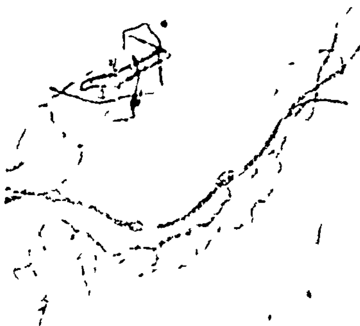


FIG 59 RACQUET MYCELIUM IN CULTURE MOUNT FROM GENUS TRICHOPHYTON × 500

becomes powdery or chalky at the periphery as it ages It is rounded often having a small central protuberance five or six radial folds can be seen Pleomorphism is not common Microscopically, only mycelium and chlamydospores are seen

Cutaneous sensitivity with resulting 'id' reaction is rare The reaction *to an intracutaneous test with trichophytin is* usually slight or absent

cream and finally takes on a yellowish hue at the center Distinct and unequal marginal rays are seen on the crackled surface Microscopically one sees terminal and intercalary chlamydospores lateral aleurospores and abundant arthrospores



FIG 61 EARLY SPORULATION IN GENUS TRICHOPHYTON × 500

TRICHOPHYTON SCHOENLEINI (LANGERON AND MILOCHEVITCH, 1930)

Synonym Achorion schoenleini

The organism causes tinea favosa and is pathogenic in man guinea pigs rats mice cats and rabbits Except in the case of rats it very rarely occurs spontaneously in these animals T schoenleini is common in southern Japan Algeria Holland

MYCOLOGY

The colony at first shows a velvety surface, which later becomes roughened and irregular The color varies from a delicate to a sulfur yellow

TRICHOPHYTON CEREBRIFORME (SABOURAUD, 1910)

This is probably a variant of T sulfureum (Sabouraud, 1910) This organism causes tinea barbae and, rarely, tinea capitis It is common in England, France, Italy, and Germany



FIG 60 TAPERING FUSEAUX (MACROCONIDIA) AND CONIDIA EN GRAPPE IN CULTURE MOUNT OF GENUS TRICHOPHYTON × 500

MYCOLOGY

At first white and having a crater that disappears as the folds become prominent, the cerebriform surface deepens to

and rather coarse In some fields the organism may be missing but vestigial traces can be found in the hairs

On Sabouraud's dextrose agar the rate of growth is usually slow About three weeks are required to obtain a recognizably



FIG 63 SPORES VARYING IN SIZE AND SHAPE (SOME SAUSAGE SHAPED) IN CRUSTS (SCUTULA) OF TI EA FAVOSA × 600

characteristic growth When full grown the colony is compact smooth and waxy it is usually described as of basket type varying from white to brown in color Pleomorphism is uncommon

Study of the hanging-drop preparation shows (1) conidia bearing hyphae with lateral and apical spores found on barley

the Rhine Valley and in eastern Germany, especially in Silesia it occurs also in Bosnia, Hungary, Poland, the Russian border states, in Transcaucasia, Bessarabia, Italy, Scotland, and occasionally in France It occurs, only rarely, in Formosa northern Japan Manchuria, the United States, Portugal, Argentina and in São Paulo, Brazil

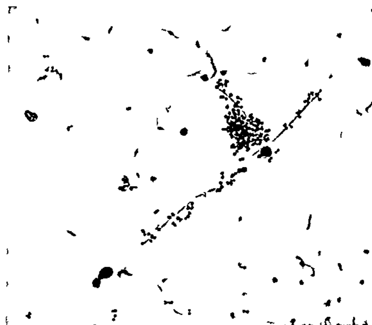


FIG 62 CONIDIA EN GRAPPE IN CULTURE MOUNT OF GENUS TRICHOPHYTON × 500

MYCOLOGY

The yellowish scales or crusts or the hair, or both provide the best material for microscopic examination This is placed on a slide, treated with 20 to 40 per cent sodium or potassium hydroxide, heated to bubbling, thinned, and cleared The microscopic field shows spores of varying size and shape Particularly typical is the sausage shaped spore Hyphae are septate

Trichophyton Concentricum (Blanchard, 1896)

Synonyms Endodermophyton concentricum Endodermophyton indicum, Endodermophyton tropicale Endodermophyton mansoni

This organism is the chief cause of tinea imbricata The disease is common where the cocoanut tree grows such as the

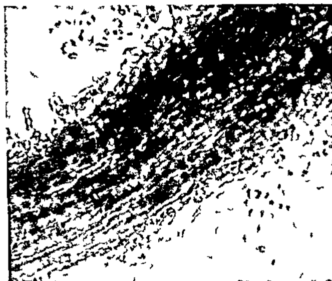


Fig 65 Spores and Mycelium in Potassium Hydroxide Preparation of Hair in Tinea Favosa × 500

Pacific Islands the Malay States and central and southern China Young adults are more prone to contract the disease and males are more susceptible than females

MYCOLOGY

On direct microscopic examination of skin scales one finds numerous interlacing segmented hyphae For cultural studies the scales should first be soaked in alcohol for five minutes to

and carrot media, on the other media, only arthrospores are present, (2) claviform bodies, with the terminal portions of some filaments swollen and claviform, some authorities compare these to the spindles of the Trichophyton and Microsporum



Fig 64 Spores and Mycelium in Potassium Hydroxide Preparation of Hair in Tinea Favosa × 600

genera though they are more slender and nonseptate—the French call them *chandeliers faviques* because of their candlestick conformation, (3) terminal chlamydospores, varying in number

Cutaneous sensitivity with resulting id reaction is rare A reaction to an intracutaneous test with trichophytin is usually absent Occasionally a mild response may be elicited

TRICHOPHYTON CONCENTRICUM (BLANCHARD 1896)

Synonyms Endodermophyton concentricum Endodermophyton indicum, Endodermophyton tropicale Endodermophyton mansoni

This organism is the chief cause of tinea imbricata The disease is common where the cocoanut tree grows such as the

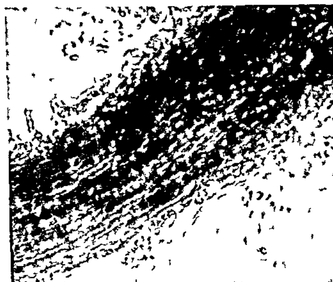


FIG 65 SPORES AND MYCELIUM IN POTASSIUM HYDROXIDE PREPARATION OF HAIR IN TINEA FAVOSA × 500

Pacific Islands the Malay States and central and southern China Young adults are more prone to contract the disease and males are more susceptible than females

MYCOLOGY

On direct microscopic examination of skin scale one finds numerous interlacing segmented hyphae For cultural studies the scales should first be soaked in alcohol for five minutes to

avoid contamination with bacteria These scales are then placed in Sabouraud's broth After several weeks the fluffy growth is transferred to Sabouraud's dextrose agar The growth on the solid medium is heaped, deeply folded, glabrous and white at first It soon becomes deep brown in the center



FIG 66 POTASSIUM HYDROXIDE PREPARATION OF SCRAPINGS FROM NAIL INFECTED WITH T SCHOENLEINI × 550

with a cream colored and powdery periphery The substrate is pigmented deep amber in color The resemblance to T schoenleini is striking On culture mount one sees numerous vegetative forms and arthrospores but no microconidia

GENUS EPIDERMOPHYTON

Species Epidermophyton inguinale (Sabouraud, 1910), Epidermophyton floccosum (Langeron and Milochevitch 1930)

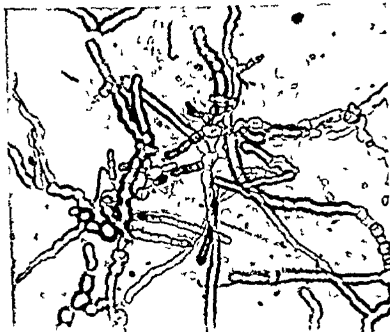


FIG 6 TRICHOPHYTON (ACHORION) SCHOENLEINI
Hanging-drop preparation showing *chandelier favique* and chlamydospores × 300

This organism produces the clinical entities tinea cruris and dermatophytosis of the hands and feet. Only glabrous skin and the nails are susceptible, the parasite showing an affinity for the skin of the inguinal fold, intergluteal fold, axillae, feet and hands. Hair is never affected.

MYCOLOGY

The colony is slow growing and greenish yellow in color, showing radial furrows. Pleomorphism occurs. Microscopic examination shows septate mycelium with terminal clavate-



Fig 68 Trichophyton (Achorion) Schoenleini
Culture mount (stained) showing *chandelier favique* and chlamydospores × 600

shaped fuseaux which may appear singly or in groups of five to seven, and chlamydospores these occasionally in abundance Aleurospores are very rare

Cutaneous sensitivity with resulting 'id' reaction is not common An intracutaneous test with trichophytin usually elicits a negative or a mildly positive reaction



FIG 69 GENUS EPIDERMOPHYTON
Culture mount showing fing r like projection of club-shaped fuseaux (macrocom dia) and absence of comid a × 700

CLINICAL CONSIDERATIONS

Tinea capitis and *tinea circinata* have already been described clinically (see pp 72–85)

TINEA FAVOSA

Clinical Picture This condition affects chiefly the scalp but can affect glabrous kin and the nails It is caused by the



FIG 70 NUMEROUS CLUB SHAPED FUSEAUX (MACROCONIDIA) IN GENUS EPIDERMOPHYTON × 700

micro organism known as Trichophyton (Achorion) schoenleini No age or sex is immune On the scalp the disease usually starts as a small inflammatory area covered with scales Yellowish (sulfur colored) crusts form around the hair follicle The crusts increase in size and finally become hollow cup shaped, pierced by hairs These crusts are known as scutula and are particularly found at the border of the involved areas Brittleness and loss of hair are typical Atrophic scarring occurs



Fig. 71. E. Floccosum

Culture mount showing chlamydospores and mycelium; conspicuous absence of microconidia. × [illegible]00

and in long-standing cases the odor is extremely offensive, frequently referred to as a mousy odor.

Favus of the scalp in adults may also resemble seborrheic dermatitis showing diffuse superficial adherent scaling with little scarring and follicular involvement. Its resistance to the usual therapy for seborrhea of the scalp should make one suspect favus. Favus of glabrous skin appears as numerous or few and scattered crusts that are yellowish and cup-shaped with no noticeable inflammation. In the nails the organism pro-



FIG 72 TINEA FAVOSA SHOWING SCARRING AND SCUTULA

duces a yellowish discoloration evidence of destruction and brittleness Primary favus of the nails in this country has been reported by one of the authors (J H S) and also by Lewis

A reaction to an intracutaneous test with trichophytin is usually absent

Animals are the most common means of transmission especially cats Other modes are direct contact with infected humans, contaminated clothing and the comb and brush

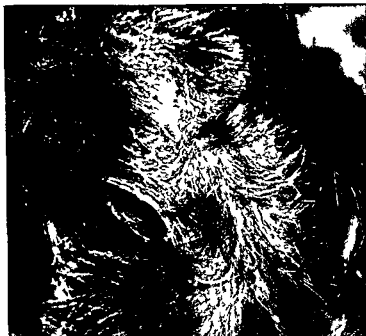


FIG 13 FAVUS OF SCALP

Treatment Since the disease is inoculable the source of infection must be found and eliminated The most effective therapeutic measure is roentgen ray epilation (see Treatment of Tinea Capitis), even this sometimes fails however Ethyl iodide inhalation is employed as in tinea capitis In most cases, a combination of roentgen ray epilation and ethyl iodide inhalation is advisable

TINEA SYCOSIS (TINEA BARBAE)

Clinical Picture The causative micro organisms are T gypseum T rosaceum T violaceum and M canis T gypseum is the cause of the majority of cases of tinea barbae This disease invades the bearded region with the exception of the

upper lip, which is only rarely involved The lesions take the form of minute to large abscesses of follicular distribution, exuding a gelatinous fluid In this fluid or in the hairs will be found mycelium and spores, verifying the diagnosis and helping



FIG 74 FAVUS OF THE SCALP AND GLABROUS SKIN

to differentiate the disorder from sycosis vulgaris The clinical picture may vary from a type simulating sycosis vulgaris to the extreme kerion type The latter is more common when the causative agent is either T gypseum or M canis



FIG 75 FAVUS OF THE SCALP (Burned out)

Treatment Two phases are important They consist of

1 Precautionary measures in shaving The patient is instructed (*a*) to use no brush because it cannot be sterilized (*b*) to shave the healthy skin first and the involved skin last (*c*) to avoid traumatizing the skin

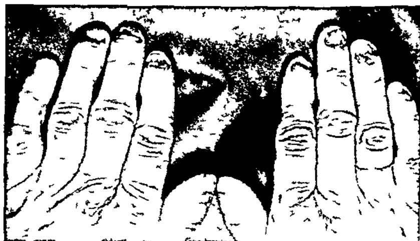


Fig 76 Favus of the Nails in Patient with Favus of the Scalp (Fig 75)

2 Manual epilation of the involved hairs and daily or twice-daily application of the following ointment

		Gm or cc
℞	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0
M		

In some extremely stubborn and extensive cases, roentgen ray epilation may be necessary and ethyl iodide inhalation can also be tried

ONYCHOMYCOSIS

Clinical Picture One or more of the nails may be invaded, giving a brittle, yellowish brown or darker and lusterless pitted appearance The parts chiefly affected are the nail bed and the lateral aspects Beneath these affected parts, particularly the lateral margins are accumulations of soft debris An accompanying inflammation about the nail is rare (paronychia) The course is chronic

Treatment Results are not very satisfactory The following measures are employed for local treatment

1 Soak the fingernails for fifteen minutes in a warm saturated solution of boric acid (1 teaspoonful of boric acid crystals to a glass of warm water)
2 Scrape the affected nail until it hurts using either the rough side of a broken glass slide or a sharp scalpel The use of a burr powered by a small motor to remove the infected nail material is advisable only in selected cases
3 Apply morning and night, after soaking one of the following ointments to the nail and beneath it

		Gm or cc
℞	Acidi salicylici	2 0
	Acidi benzoici	2 0
	Petrolati	*30 0*
ℳ		

		Gm or cc
℞	Mercurochrome crystals	0 6
	Aquae	1 2
	Acidi salicylici	2 0
	Petrolati	
	Lanolini aa ad	30 0
ℳ		

	Gm or cc
Sodium propionate	9 84
Propionic acid	2 16
N propyl alcohol	6 0
Zinc carbonate	3 0
Carbowax 4000	39 0

A sodium perborate paste made up of a few drops of water added to sodium perborate powder is applied to the fingernail and nail bed and covered with a rubber finger cot and allowed to remain overnight

In roentgen ray therapy, each nail is treated separately the skin being protected with a lead filter

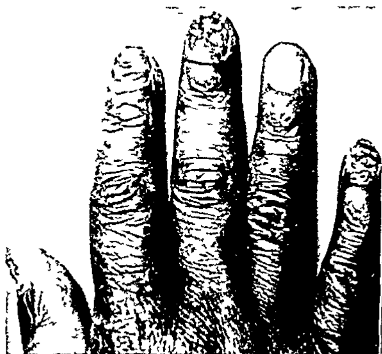


FIG 77 ONYCHOMYCOSIS (T RUBRUM)

Surgery, followed by local treatment, is also employed but only as a last resort The nail is removed surgically and the nail bed is soaked in boric acid solution as described above, this is followed by application of the mercurochrome ointment

Ethyl iodide inhalations are rather disappointing in onychomycosis

DERMATOPHYTOSIS

Also known as epidermomycosis, dermatomycosis, and eczema mycoticum this term usually refers to a superficial fungus infection of intertrigenous or other areas of the glabrous skin Under this heading are included tinea pedis tinea manuum, allergic manifestations (dermatophytids), and tinea

cruris Onychomycosis is discussed separately (see p 120) Tinea pedis or tinea manuum may be accompanied by nail involvement The inflammatory and acute type of this disease is more frequently caused by T gypseum whereas the chronic type is more frequently seen when T rubrum (purpureum) is the causative agent

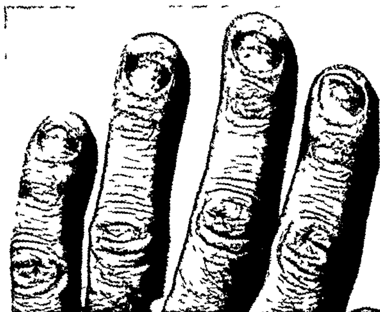


Fig 78 Onychomycosis (T Gypseum)

Tinea pedis and tinea manuum are rare in children under the age of puberty and such a diagnosis in children should be made only when supported by direct microscopic examination and cultural studies Tinea manuum is not a common occurrence in children or adults Not every vesicular or scaly eruption on the hands is due to a fungus infection When a diagnosis of tinea manuum is made, the burden of proof is on

the one who makes the diagnosis and should therefore be supported by positive mycologic studies

This clinical entity may take any one of several distinct forms or represent a combination of all of them, with one form predominating The eruption is erythematous, papular, scaly, vesicular, macerated fissured, or hyperkeratotic

Erythematous Form This form usually consists of a patch of erythema, often sharply demarcated, especially at the lower



FIG 79 DERMATOPHYTOSIS OF FOOT (INTERTRIGENOUS TYPE)

border with slight elevation and minute vesiculation Clearing in the center may take place In brunettes or in persons with a tendency to pigment, superpigmentation in varying degrees may be noted Lichenification is present in long standing cases In folds, there are also maceration fissuring papulation and pustulation The seat of predilection of this type of lesion is the upper inner aspect of the thigh with extension to the groin and posteriorly to the intergluteal fold

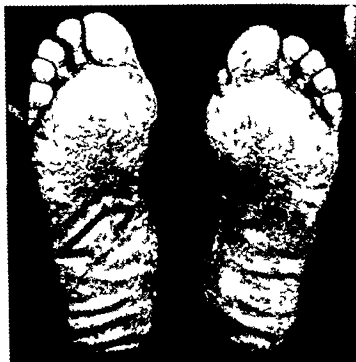


FIG 80 DERMATOPHYTOSIS OF FOOT (SCALY TYPE)

At times the genitalia are involved The progress of the eruption may be upward and may involve the pubis but never the pubic hair The thighs and their environs are not the only seat of this form of dermatophytosis The axillae are not infrequently infected The area under the breasts especially when they are pendulous may become involved and in addition to erythema and fine scaling there may be papulation and pustulation

Papular Form This type of the disease is rather less common It may occur on the free surfaces or where cutaneous areas oppose each other In the former case the eruption is



FIG 81 DERMATOPHYTOSIS OF FOOT (VESICULAR TYPE)

dry whereas in the latter the lesions become red, moist, erosive, and show superimposed pustulation

Scaly Form Scaling in dermatophytosis may be a primary process or may be secondary to any other form of the disease In the primary type, scales are most commonly observed on the *sides of the fingers or on the toes in their webs on the palms,* or on the soles The scales may be few, or they may be so *pronounced or so numerous* that the patient himself cannot fail to observe them The fourth interspace is the favorite seat of



FIG 89 DERMATOPHYTOSIS OF FOOT (HYPERKERATOTIC TYPE)

the scales followed by the third interspace as a poor second The fourth interspace of the left foot is usually more frequently and more noticeably involved

Vesicular Form This is the most common form of the disease It is seen as primary lesions on the palms the lateral and palmar aspects of fingers, the soles of the feet and the toes The vesicles are usually intradermal They tend to be discrete but may coalesce The vesicles often have a dark steel blue center and turn brown with age Bullae may be present On the soles of the feet the vesicles are most frequently seen on the arch

Macerated Form The seats of predilection of this form are the webs of the toes, the intergluteal fold, the contact points of the penis and scrotum, the submammary folds, and the axillary folds The fourth toe space, particularly that of the left foot, is the most common site Inflammation may or may not accompany this form, it is most frequently seen in the intergluteal and submammary folds

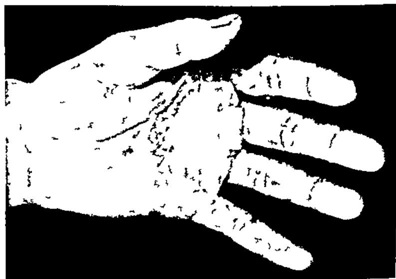


FIG 83 DERMATOPHYTOSIS OF HAND

Fissured Form This form is relatively more frequently seen between toes It may be found accompanying the hyperkeratotic type of epidermophytosis on the soles of the feet Fissuring in the intergluteal and submammary folds is usually not primary but accompanies the macerated or erythematous form

Hyperkeratotic Form This is particularly seen on the soles of the feet and occasionally on the palms The lesions ap-



FIG 84 DERMATOPHYTOSIS OF HAND (HYPERKERATOTIC TYPE) Patient had nail involvement (Fig 8)

pear as orange colored hyperkeratotic areas accompanied by fissuring sometimes quite deep and painful

A concomitant toxic or allergic eruption known widely as *trichophytid* may also be present It is symmetric and appears commonly on the extremities particularly the upper ones It may be macular papular or vesicular in character or follicular lichenified, or squamous The organism cannot be seen microscopically in these lesions

The form of infection that involves the upper regions of the thighs and sometimes extends to the perineum and beyond to

the intergluteal fold, is frequently called eczema marginatum, *tinea cruris*, or dhobie itch The characteristic lesion is a patch of erythema often sharply demarcated and showing maceration in the fold and a slightly elevated border frequently consisting of pin-point vesicles It tends to clear centrally while extending peripherally In brunettes or persons with a tendency to pigment, superpigmentation in varying degrees



FIG 85 TRICHOPHYTON RUBRUM (PURPUREUM) INFECTION

may be noted Lichenification is present in long standing cases Because of the heat and moisture in the intergluteal fold the predominating characteristics may be maceration and fissuring

Lymphangitis and regional lymphadenitis may complicate dermatophytosis particularly when the lower extremities are involved These are usually due to a superimposed bacterial infection but may be due directly to the fungus infection

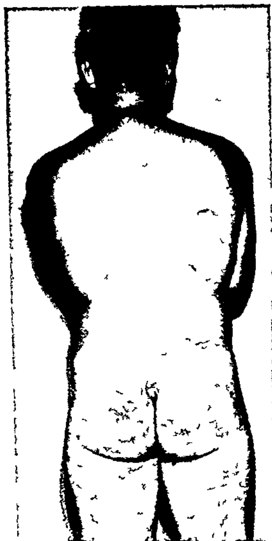


Fig 80 Trichophyton Rubrum (Purpureum) Infection

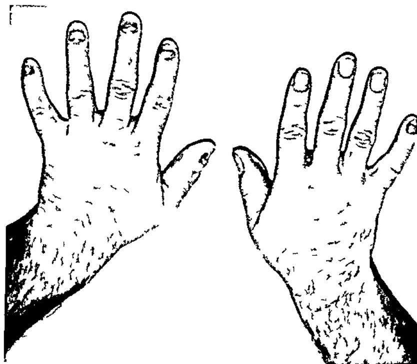


FIG 87 TRICHOPHYTON RUBRUM (PURPUREUM) INFECTION IN PATIENT SHOWN IN FIG 86

Dermatophytosis caused by T rubrum or T purpureum appears as an extensive, rather stubborn infection of glabrous skin and nails, clinically resembling the ordinary dermatophytosis produced by T gypseum, or taking the form of a bizarre pattern of lesions involving the trunk and extremities This infection is notable for its chronic character Trichophyton rubrum practically never produces vesiculation or acute reaction Hopkins and his group, however, reported vesicular lesions in many of the patients with T rubrum infections studied at Fort Benning 1942–45 This may be explained by a difference in strain of T rubrum, climate, and possibly by increased sensitivity of the host

The absence of vesiculation, acute reaction and the presence of chronicity should suggest T rubrum as the causative agent of tinea pedis and tinea manuum but in the final analysis cultural study is the most accurate means of determining the causative micro-organism The condition has been described in detail by Lewis Montgomery and Hopper and by the author (J H S) and Conant



Fig 88 Vesicular Dermatophytid

Tricophytid Epidermophytid Dermatophytid The so-called id eruptions are manifestations of cutaneous allergy due to a hematogenous extension from an active focus of fungus infection The lesions in themselves are sterile—that is the presence of fungi cannot be demonstrated either by direct microscopic examination or by culture The eruption varies from an

eczematous, vesicular, or erythematous type to one simulating erythema multiforme The extremities are the most common site The term dermatophytid has been considerably abused particularly in the United States Erythematous, vesicular, and eczematous eruptions on the hand have been carelessly labelled dermatophytid without any proof of a focus of infec

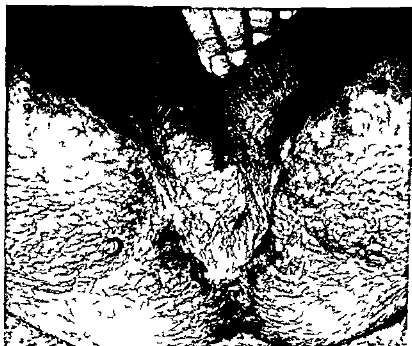


FIG 89 TINEA CRURIS (E FLOCCOSUM)

tion For a definite diagnosis of dermatophytid, an active focus must be present A positive trichophytin test is helpful The eruption should clear with the subsidence of the active focal infection except when there are secondary eczematous changes due to sensitivity to other substances or to overtreatment

Treatment There is no specific treatment in dermatophytosis An accurate diagnosis is essential for proper treatment A clinical diagnosis should always be confirmed by direct microscopic examinations and cultural studies The latter will assist in determining the prognosis and the type of therapy since treatment is based upon the type of fungus isolated cutaneous sensitization or the lack of it and the clinical findings If T gypseum is cultured from the lesions therapy is usually effective On the other hand if T rubrum is the offending agent, response to therapy is not too good In the *acute stage* one cannot stress too much the importance of gentle nonirritating treatment Warm boric soaks or potassium permanganate (1 5 000) soaks should be used for ten to fifteen minutes two or three times a day followed by the use of a soothing antipruritic lotion

		Gm or cc
℞	Mentholis	0 3
	Zinci oxidi	8 0
	Calamini	4 0
	Phenolis	2 0
	Liquor calcis ad	240 0

M

When desquammation or crusting takes place this treatment is continued with the addition of the following ointment

		Gm or cc
℞	Acidi borici	[illegible] 0
	Zinci oxidi	2 0
	Amyli	8 0
	Petrolati	30 0

M

Rest and elevation of the extremities are essential The patient is not to use stimulating or irritating preparations

In the *chronic stage* effective local treatment may be given in the form of fungicidal preparations iodine thymol oil of cinnamon chrysarobin potassium permanganate copper sulfate gentian violet mercurochrome sodium hyposulfite

sulfur, benzoic acid, and salicylic acid. A keratolytic agent and a soft penetrating base are necessary in most cases.

The following are some of the ointments in use:

		Gm. or cc.
℞	Iodine crystals	0.3–0.6
	Potassium iodide (enough to dissolve iodine)	
	Acidi salicylici	2.0
	Lanolini	
	Petrolati āā ad	30.0
M.		

℞	Mercurochrome crystals	0.6–1.2
	Aquae	1.2–1.8
	Acidi salicylici	2.0
	Lanolini	
	Petrolati āā ad	30.0
M.		

(Useful in vesicular and pustular types)

℞	Acidi salicylici	2.0
	Sulphuris praecipitatis	2.0
	Petrolati	30.0
M.		

℞	Acidi salicylici	2.0
	Acidi benzoici	4.0
	Adipis	30.0
M.		

(Whitfield's ointment)

		Gm. or cc.
℞	Acidi salicylici	1.0
	Acidi benzoici	1.5
	Paraffini mollis	8.0
	Olei cocois nuciferae	30.0
M.		

(Modified Whitfield's ointment)

℞	Thymolis	0.3
	Acidi salicylici	2.0
	Sulphuris praecipitatis	2.0
	Petrolati	30.0
M.		

℞	Chrysarobini	1 0
	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0

M

(Useful for the hyperkeratotic type)

	Gm or cc
Sodium propionate*	12 3
Propionic acid	2 7
Sodium caprylate	10 0
Zinc caprylate	5 0
Dioctyl sodium sulfosuccinate	0 1
Carbowax 4000	69 9

M

Hopkins and his co-workers found undecylenic acid (5 per cent) in carbowax to be effective

Potassium permanganate in the strength of 0 05 to 1 per cent is used effectively in the vesicular stage either alone or together with any of the above given ointments In all instances the application of the ointment should be preceded by soaking of the hands or feet in a warm saturated solution of boric acid

After subsidence of the infection the ointment is used at night only instead of both morning and night The soakings however are continued twice daily and in the morning can be followed by a light dusting with zinc oxide boric acid and talc in equal parts or with the following

		Percentage
℞	Acidi salicylici	2 0
	Acidi benzoici	2 0
	Talci	96 0

M

	Gm or cc
Calcium propionate	15 0
Zinc propionate	5 0
Zinc caprylate	5 0
Base	75 0

* May be obtained from the Mycoloid Laboratories Inc Little Falls New Jersey as sopronol ointment and sopronol powder respectively

Instructions to be given the patient as to treatment are as follows

Evening treatment

1 Soak the feet or hands for fifteen minutes in either a saturated solution of boric acid or 1 5,000 potassium permanganate
2 Dry the affected parts with paper tissue or old towel Do not use this towel on the rest of the body Use a soft moist cotton ball to remove all loose skin
3 Cover a toothpick with cotton and lightly brush the affected parts with ointment Place a small piece of cotton cloth or bandage between the fingers or toes to prevent the skin areas from touching
4 Protect bed linen by wearing old cotton stockings The heel of a woman's stocking and the leg part are cut out, making two ties that can be fastened about the ankle to hold the dressing in position On hands wear cotton gloves from which the fingertips have been cut off

Morning treatment

Wipe off all of the old ointment with a piece of tissue or cotton cloth Powder the interdigital spaces and the insides of stockings and gloves

If the feet only are affected, wash the hands carefully after treating the feet

Care of wearing apparel

Proper equipment includes paper towels 1 pint of formalin a paper bag Gather together all shoes and slippers worn during the infection Soak paper towels in formalin and carefully protecting the hands stuff the soaked papers into the shoes and slippers Place them in a large paper bag, tie this with string and place it in a closet for twelve hours to fumigate Remove the paper and place the shoes

and slippers in the sun for at least twenty four hours to air before wearing them again

Wear cotton stockings or gloves that can be boiled

In acute vesicular infections, in those with accompanying epidermophytid or trichophytid, and in all stubborn, long standing cases, ethyl iodide inhalation is effective and may be used The inhaler of choice is one so designed as to allow a comfortable mixture of ethyl iodide and air The initial dose is 1 5 cc (3 Gm) this is increased by 0 5 cc (1 Gm) per dose until 3 cc is reached or in the case of larger individuals 4 cc It usually requires about a half hour to inhale a dose of 3 cc of the mixture To avoid a cumulative effect inhalations are given on two successive days then omitted on the third *Ethyl iodide should never be administered to patients suffering from pulmonary tuberculosis toxic goiter or nephritis* The number of treatments varies with the site of the infection its duration and the nature of the invading organism Yeast infections are relatively more resistant to treatment For complications see Treatment of Moniliasis (p 56)

The use of ionization with copper sulfate described by Strauss and Haggard has been tried by the author in too few cases to provide sufficient basis for comment

Tincture of metaphen has been found helpful in the inter digital and macerative types of infection

In long standing cases where lichenification and a good deal of pruritus are present roentgen ray therapy unfiltered in doses of 50 to 75 r has proved helpful Roentgen rays are a poor fungicidal agent in doses that are harmless to the skin

PROPHYLAXIS

Since mycotic organisms grow best in warm moist areas preventive measures should be based on proper care of the body and on the elimination of every potential source of infec tion The most common type of fungus infection seen by der matologists is that which invades the feet In an institution

such an infection becomes a serious problem Prevention is possible if a few precautionary measures are observed and a general understanding of foot hygiene is maintained

The chief rules of prophylaxis are

1 Do not walk on floors in bare feet
2 Do not wear any but your own slippers or shoes
3 Place a towel on the floor of the shower or wear rubber bathing slippers
4 Step from the tub or shower on to a fresh bath mat or newspapers
5 Wash the feet at least once daily with soap and water
6 Dry the feet thoroughly leaving no moisture between the toes Use a separate towel for the rest of body if any sign of infection, such as cracking itching, or burning, is present Powder the feet lightly, especially between the toes using any borated (unscented) talcum An excellent powder is a combination of equal parts of boric acid, zinc oxide, and talcum
7 Boil all towels

Care of the body

Persons who perspire freely are more susceptible than others to fungus infections Daily baths and thorough drying of the body are essential Application of an astringent lotion or powder to affected areas is helpful

Care of the hands

Hands sensitive to soap and water or hands that perspire easily, predispose to all types of skin infection Care must be taken to observe the following precautionary measures

1 Use a superfatted soap
2 Dry the hands carefully Never allow the hands to remain half damp If there is a tendency to cracking, rub in toilet lanolin at least once daily

3 If the hands perspire soak them at least once a day in boric acid solution (1 teaspoonful to 1 pint of water) Never wear kid or tight gloves wear cotton gloves and wash them after each wearing Hydrosol solution (7 per cent), or a 10 per cent solution of aluminum chloride may be applied at night

Rules applying to wearing apparel

1 Clothing Clothing is a frequent source of reinfection The underclothes should be of cotton and should be changed daily Clothes should be washed with a bland neutral soap and boiled or pressed with a hot iron Woolen sweaters or dresses should never be worn without some protection such as dress shields or a lining The necessity of cleansing such dresses and sweaters frequently airing them weekly in the sun, and pressing them with a hot iron cannot be overemphasized
2 Stockings Wear light cotton or silk stockings Change at least once a day Place soiled stockings in a separate laundry bag When washing stockings use mild neutral soap Whenever possible dry them outdoors in the sun or press the feet of stockings with a hot iron before wearing Never wear woolen stockings if the feet perspire
3 Shoes Two pairs of light weight shoes are essential Change shoes at least once a day Never wear rubber soled shoes or sneakers as these make the feet perspire Shoes with perforated tops are advisable in warm weather

Care of bathroom and shower

These should preferably be in a sunny part of the house and the floors should be kept scrupulously clean and free of excess moisture The floor of the shower should be such as not to allow water to collect and remain stagnant The value of the antiseptic foot bath before and after tubbing has not been satisfactorily demonstrated

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Swimming pool precaution

The use of personal bathing shoes in going to and from a pool should be insisted upon

TINEA IMBRICATA (TOKELAU)

This is a superficial fungus disease seen chiefly in the tropics or subtropics and caused by a micro organism known as T concentricum (E concentricum) The infection begins as one or more brownish macules slowly increasing in size and forming concentric rings surrounded by a brownish zone As a result of coalescence of adjacent concentric rings, polymorphic and polycyclic patches develop which are characteristic for this disease Scaling is usually profuse with little or no underlying erythema Any part of the integument may become involved, including the nails The hair follicles are usually spared As a rule, itching is intense

Treatment The use of 5 or 10 per cent chrysarobin in aquaphor is recommended Salicylic acid 6 per cent and sulfur precipitate 6 per cent in aquaphor, or Whitfield s ointment may be tried

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CHAPTER VI

OTHER PATHOGENIC FUNGI

Blastomyces Dermatitidis

In a case diagnosed as scrofuloderma Gilchrist in 1894 reported finding in a section of diseased skin a parasitic yeastlike body Two years later he published with Stokes the report of a second case in which this organism was discovered, and in 1898 in an extended study, named it Blastomyces dermatitidis Since then, numerous reports on this fungus by various authors have appeared in the literature most of them coming from the region around Chicago

MYCOLOGY

A drop of either pus or sputum with or without the addition of potassium hydroxide is placed on a clean slide for direct microscopic examination Budding thick-walled round or oval granular cells from 8 to 10 microns or more in diameter may be observed If the suspected organism does not show budding the cover glass used for the material not treated with potassium hydroxide may be rimmed with vaseline After from twenty four to forty-eight hours of incubation at room temperature budding may be noted

On culture (dextrose agar) at room temperature the colonies first appear smooth and grayish soon becoming filamentous and white with a central umbo A peripheral moist zone is usually present On culture (blood agar) at 37 C the surface growth is yeastlike not filamentous

Microscopic examination of a culture mount (dextrose agar) shows mycelium with lateral conidia and chlamydospores Occasionally racquet mycelium may be noted On blood agar mounts one sees budding cells similar to those seen in lesions, and occasional short filaments of three or four cells

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ANIMAL INOCULATION

The order of susceptibility is as follows mice, rats, rabbits, guinea pigs

IMMUNOLOGIC REACTION

Martin and Smith found that the majority of patients with blastomycosis react strongly to a heat-killed vaccine made from the yeastlike form of B dermatitidis Jacobson was unable to demonstrate specific reactions to vaccines Cross sensitization with histoplasmin and occasionally with other antigens have been reported

CLINICAL MANIFESTATIONS

The clinical picture is protean it may simulate that of syphilis, tuberculosis, neoplasm, or disorders caused by other pathogenic fungi The lesions may also resemble those of iodide or bromide sensitivity The disease may take a cutaneous (primary and secondary) or systemic form

Cutaneous Blastomycosis In the *primary* form, the *initial* lesion is seen usually on the face, hands, wrists, and forearms, although it may appear anywhere on the skin It is characteristically a papulopustule that soon becomes partially or wholly covered by a crust Beneath the crust are irregular papilliform elevations and a seropurulent secretion Peripheral growth of individual lesions and the appearance of new ones cause the formation of elevated various sized plaques Ormsby stresses the characteristic smooth purplish or dusky red border that slopes down abruptly to normal skin In the border are superficial or deep minute abscesses that are visible only through a magnifying lens These are the best material for recovery of the organism Besides this type of lesion there are sometimes observed also a verrucous type simulating verrucous tuberculosis, and a deep seated gummatous type Spontaneous healing results in scarring

The lesions of *secondary* cutaneous blastomycosis, the result



FIG 90 BLASTOMYCOSIS ORGANISMS IN PUS
Potassium hydroxide preparation × 950

of systemic blastomycosis may simulate those of primary cutaneous blastomycosis or appear as ulcers usually having their origin in superficial or deep abscesses The latter are usually associated with destructive processes in the bones muscles, and other deep tissues and organs Perinephric psoas abdominal thoracic and retropharyngeal abscesses of various size have been found

Pulmonary Blastomycosis The pulmonary involvement is more commonly primary but may be secondary to a focus in the skin Systemic blastomycosis also shows an affinity for the lungs The onset may be rapid and acute or marked by



FIG 91 BLASTOMYCOSIS
Culture mount grown at room temperature × 600

transient mild symptoms In the former case chill pain in the chest fever increased respiratory rate rapid pulse cough and expectoration of blood tinged sputum are characteristic The chest signs resemble those of other pulmonary and pleural disorders The chest films may show, in early cases no parenchymal lesions The only finding may be an enlargement of the mediastinal lymph nodes As a rule one finds dense masses located near the hilum and projecting into the lung fields with irregular outlines Cavities are usually not the rule but when present they are small irregular and with hazy out-

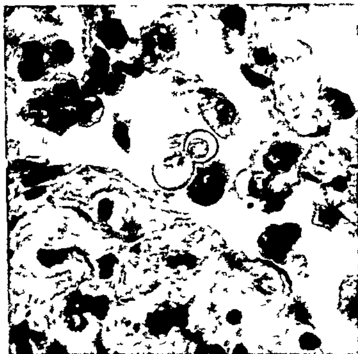


FIG 92 BLASTOMYCOSIS MICRO-ORGANISM IN TISSUE

lines In systemic blastomycosis when the lungs are secondarily involved the pulmonary shadows may resemble miliary tuberculosis

Cerebrospinal Blastomycosis Although a primary form has been reported this occurs chiefly as a metastatic process secondary to systemic blastomycosis The clinical manifestations do not differ from those of cerebrospinal infection due to other organisms The possibility of blastomycetic etiology should always be considered in obscure cerebrospinal disease Microscopic and culture studies for the presence of Blastomyces and other fungi should be a part of every routine spinal fluid examination

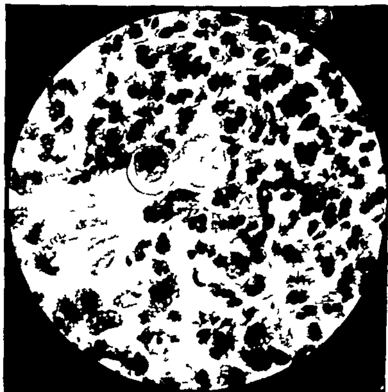


FIG 93 BLASTOMYCOSIS MICRO-ORGANISM IN TISSUE

The skin and lungs are the organs most commonly affected in systemic blastomycosis Next in order of frequency are the kidneys spleen bones and joints, liver, pleura lymph nodes, brain vertebrae skull bones prostate, pericardium meninges, myocardium endocardium, pancreas peritoneum, testicles, eyes adrenals, larynx and trachea, gastro-intestinal tract, bladder spinal cord, and tongue

TREATMENT

In the cutaneous type *surgery* is recommended if the lesion is small Some cases respond to surgical diathermy or actual



FIG 94 BLASTOMYCOSIS

cautery *Roentgen ray* therapy is effective alone or in combination with surgery The dosage advised is 75 to 100 r filtered through 1 mm aluminum once a week It is not advisable to exceed a total dose of 1,200 to 1,500 r Conant and his associates warn against the use of roentgen ray therapy in patients with hypersensitivity to blastomycin before partial desensitization with injections of blastomycin vaccine has been produced Saturated solution of potassium iodide can be given orally in large doses just below the level of toxicity Iodine has been administered intravenously with good results The use of ethyl iodide inhalations is advised in extensive primary cutaneous blastomycosis and in systemic blastomycosis

with or without cutaneous manifestations, particularly in the presence of pulmonary involvement. The initial dose of 2 cc is increased by 0.5 cc per dose until 4 cc is reached. Treatment should be given on two successive days and omitted on the third. Martin and Smith suggest desensitization with vaccine before instituting iodide therapy. They recommend the following technic: A skin test with a standardized heat killed blastomycin vaccine is done by injection intracutaneously of 0.1 cc of the vaccine. The size of the maximal reaction is determined by observation of the site of injection at intervals of twenty-four and forty eight hours. A reaction of 1 cm or more in diameter indicates hypersensitivity. The size of reaction observed determines the dilution of the vaccine required for the first desensitization. A dilution of 1:100 is used for the first injection if the reaction is from 1 to 2 cm in diameter. A 1:1 000 and 1:10 000 dilution is used for reactions of 2 cm and 3 cm in diameter, respectively. The proper dilution is injected subcutaneously, beginning with 0.1 cc. The dose is increased by 0.1 cc until 1 cc is reached. Injections are given three times a week. This procedure is repeated with each lower dilution until undiluted vaccine is used. A local or general reaction is a sign to stop injections. These may be resumed several days later with a dilution of one tenth as strong as the one that produced the reaction. Complete desensitization is not to be expected, but a definite reduction in the size of the erythematous reaction takes place indicating a decrease in hypersensitivity. Specific *vaccino-therapy* has not yet been proved of value although Stober reported clinical improvement through use of this method. Jacobson recommends intramuscular injections of colloidal copper. The author has had no experience with this form of treatment. Martin reports occasional benefit from the use of *antiblastomyces rabbit serum*. *Sulfonamides* have not proved too effective although several questionably favorable reports have appeared in the literature. Noojin and Callaway found that the inhibition of growth of



FIG 95 BLASTOMYCOSIS BRASILIENSIS

Culture mount from beef infusion glucose agar 37° C × 600 (Courtesy of Conant et al)

Blastomyces dermatitidis in vitro required concentrations well above the maximum clinical drug levels tolerated They therefore concluded that sulfonamide compounds are not practical if used orally and parenterally *Streptomycin* and *penicillin* have thus far proved of doubtful therapeutic value in the treatment of this disease Myers and Ordal have shown that Blastomyces dermatitidis was sensitive to gliotoxin in vitro but that the drug was extremely toxic to the chick embryo

Whatever form of therapy is adopted sunshine and a high caloric diet especially in systemic blastomycosis are a vital necessity

PARACOCCIDIOIDES (BLASTOMYCES) BRASILIENSIS (SPLENDONE DE ALMEIDA 1930)

This organism causes the disease known as paracoccidioidal granuloma (South American blastomycosis), reported from



FIG 96 BLASTOMYCOSIS BRASILIENSIS

Culture mount grown at room temperature × 600 (Courtesy of Conant et al Manual of Clinical Mycology W B Saunders Co 1944 p 82 Fig 42 C)

Brazil by Lutz in 1908 Although it has not yet been reported in this country, it is included in the discussion here since the clinical picture is similar in some respects to that of blastomycosis caused by Blastomyces dermatitidis as well as to that of coccidioidal granuloma (see pp 146 148)

MYCOLOGY

Paracoccidioides brasiliensis appears in the tissue or pus as single- or multiple-budding thick walled yeastlike cells The buds are excessively small—coccoid in fact The single-budding cells from 10 to 30 microns in diameter are similar to those seen in the organism causing Gilchrist s disease The multiple-budding cells as large as 60 microns in diameter, are diagnostic for this disease Buds of 1 micron or more in diameter may be attached to and surround the parent cell

Diagnosis is made by direct microscopic examination of material from the lesions Crusts scrapings from the lesions



Fig 97 Mucocutaneous South American Blastomycosis
(Courtesy of de Almeida Mycologia Medica Companhia Melhoramentos de São Paulo Brazil 1939 Fig 121)

and pus should be placed in 10 per cent potassium hydroxide and examined under a cover glass Cultures should be made on Sabouraud s glucose agar and beef infusion or blood agar at both room temperature and at 37 C On Sabouraud s agar at room temperature the primary culture may remain heaped compact cerebriform (similar to Achorion schoenleini) and show microscopically several budding forms identical with those seen in lesions These cultures become filamentous after some time and develop a short nap of white aerial mycelium

On blood agar at 37 C, the cultures remain yeastlike, waxy, and composed of the same type of single- and multiple-budding forms as are seen in the lesions

CLINICAL MANIFESTATIONS

The individual lesions are clinically and histologically similar to those of Gilchrist's disease and coccidioidal granuloma Enlargement of the lymph nodes, suggesting Hodgkin's disease, is the most characteristic single clinical finding in all cases of South American blastomycosis De Almeida and other South American workers classify the disease as follows (1) Mucocutaneous form, (2) lymphangitic form, (3) visceral form

The *muco-cutaneous* form The primary lesions usually occur either on the skin around the mouth or nose, or on the mucosal surface of the tongue, gums cheek, lips or nose On the mucosa, the primary lesion is usually a small papule which soon ulcerates, enlarging peripherally and into the deeper structures New lesions continue to appear until there is extensive involvement which may result in complete destruction of the epiglottis, vocal cord, and uvula The regional lymph nodes become enlarged and undergo necrosis and finally rupture through the skin, giving rise to permanent draining sinuses The lymph nodes in the axillary and inguinal areas may become similarly involved as a result of the dissemination of the micro-organism through the blood stream The lesions are painful and cause considerable difficulty in swallowing, resulting in malnutrition Death is usually the result of starvation and terminal pyogenic infection The cutaneous lesions are granulomatous and may or may not ulcerate

The *lymphangitic* form is characterized by massive lymph node enlargement, particularly in the neck region The overlying skin becomes secondarily involved when the lymph nodes become necrotic and drain through the skin

In the *visceral* form the portal of entry is believed to be the gastro-intestinal tract with ultimate dissemination of the infec-

tion resulting in involvement of the spleen liver, and other organs Abdominal pain, severe gastro intestinal disturbances including anorexia and vomiting may be present The presence of abdominal pain helps to differentiate this disease from granuloma coccidioides since the intestinal tract is not involved in the latter Lung involvement is usually secondary and is present in about 20 per cent of the patients with the visceral type of infection

TREATMENT

The disease may run either an acute or a chronic course and almost always terminates fatally Few verified cures have been reported Iodide therapy has been reported effective in some cases by de Almeida The mode of administration is the same as that for North American blastomycosis Sulfonamides have been reported effective if given over a long period

Histoplasma Capsulatum (Darling, 1906)

In 1906 Darling described the organism Histoplasma capsulatum and the postmortem findings in 3 cases of histoplasmosis In 1912 Da Rocha Lima expressed the view that Histoplasma capsulatum is closely related to Cryptococcus farciminosus the etiologic organism in epizootic lymphangitis occurring in horses In 1933 De Monbreun discovered that the organism could be cultured and grown in yeastlike and mycelial form By reproducing the disease in monkeys by intravenous inoculation he further identified the fungus as the etiologic agent of histoplasmosis Since then several cases in both adults and infants have been reported

MYCOLOGY

The organism is small encapsulated, oval shaped and from 1 to 3 microns in length It is usually found in the mononuclear cells in peripheral blood smears sternal bone marrow smears sections of spleen, also in biopsy sections of skin and lymph nodes and in blood cultures In sections of the tissue

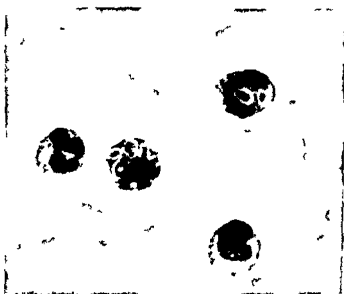


Fig 98 Histoplasma Capsulatum
Bone marrow smear with organisms in polymorphonuclear nucleus × 1300
(Courtesy of Conant et al)



Fig 99 Histoplasma Capsulatum
Culture mount from blood agar at 37° C × 700

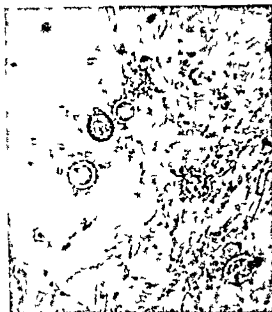


FIG 100 HISTOPLASMA CAPSULATUM

Culture mount on Sabouraud s me lium at room temperature (Courtesy of Conant J Bacteriol 41 5(1941 Fig 3 Plate 11)

suspected and stained after Bensley s procedure the parasites appear stained deep red

The organism may be cultured on Sabouraud s media or in sealed blood agar tubes On Sabouraud s media and grown at room temperature the growth is moldlike On culture mount one sees large warty thick walled chlamydospores at tached to the fungus filaments The growth on sealed blood agar tubes at 37 C is yeastlike On culture mount one sees budding and nonbudding yeastlike cells

CLINICAL MANIFESTATIONS

The clinical picture described by Darling comprises emacia tion weakness pyrexia anemia leukopenia and splenomegaly

Variations in the symptomatology have been reported, with some of the above named symptoms lacking. In children the first evidence of the disease may be in the gastro intestinal tract with nausea and diarrhea. Henderson, Pinkerton, and Moore found ulcerative enteritis as the chief lesion in their case. Lymphadenopathy is present, including the mesenteric lymph nodes, but this finding is more marked in adults than in children. The lungs may be either primarily or secondarily involved. Pulmonary involvement is the rule in generalized cases. Bone lesions, enlargement of the liver, as well as adrenal involvement have been reported. Skin findings varying from a dusky erythema to purpuric spots or to urticarial lesions have been recorded. Ulcerative lesions of the skin, tongue, nasopharynx or larynx have also been reported. It is advisable to consider histoplasmosis in the differential diagnosis of any obscure case of splenomegaly, especially if the splenomegaly is associated with intermittent pyrexia, cachexia, and leukopenia.

Palmer, Christie and Peterson believe that there is prevalent in certain parts of the country a mild subclinical infection with H. capsulatum from which recovery takes place. They base their claim on the finding of pulmonary calcification in patients showing negative reactions to tuberculin and coccidioidin and positive reactions to histoplasmin. They recognize, however, that cross sensitization with blastomycin and coccidioidin may exist.

Cutaneous reaction to histoplasmin in infected individuals may be tuberculin like (delayed) and immediate.

On *pathologic* examination one finds in the spleen, liver, lungs and intestines, as well as in other tissues, gray and white nodules. Involvement of the mesenteric lymph nodes is the rule. The lesions are necrotic, not unlike those seen in tuberculosis. The fungus is found in the fixed reticulo-endothelial cells in the spleen and liver, whereas in other parts of the body it may be found in the phagocytic cells.

TREATMENT

No specific therapy has been given sufficient trial in this disease because diagnoses usually have been made after necropsy In the few cases recognized before death and treated, results have been unsatisfactory The following treatments have been reported ionized copper, massive doses of potassium iodide local x ray treatment and sulfonamides The therapeutic results reported with the use of penicillin have not been favorable Meleney recommends the antimony preparations such as antimony sodium tartrate the trivalent organic compound such as fuadin, or the pentavalent preparation such as neostam Mantel, Troy, and Kendall report clinical improvement in one case treated with neostam

Rhinosporidium Seeberi

This micro-organism is the cause of rhinosporidiosis a rare mycotic disease with a predilection for the mucous membrane of the nose The eyes ears, larynx, and occasionally the vagina penis and skin may become involved The disease occurs spontaneously in cows, horses and mules

MYCOLOGY

Direct microscopic examination of material from the polypoid masses reveals round to ovoid spores 7 to 9 microns in diameter and spore filled sporangia The sporangia are large (up to 250 to 300 microns in diameter) Slides from biopsy section stained with hematoxylin and eosin show the large thick walled sporangia filled with endospores as well as empty ones Ruptured sporangia and endospores scattered about on the epithelial surface or throughout the tissue may also be seen

The cultural characteristics of this fungus are not known since it does not grow on ordinary laboratory media

CLINICAL MANIFESTATIONS

The nose especially the anterior nares is the most common site of infection Occasionally it spreads to other sites on the

face, to the posterior pharynx and larynx The large polyps may produce nasal obstruction dyspnea, and dysphagia The infection may begin as a mucoid discharge and severe itching The lesions develop slowly are sessile on the mucosa, but as the tumor masses develop they become pedunculated The fully developed swellings are globoid or polypoid and may eventually weigh up to 20 Gm The color of the lesions varies from pale pink to deep purplish red the surface is covered with sticky mucus Older lesions become verrucous and may resemble a

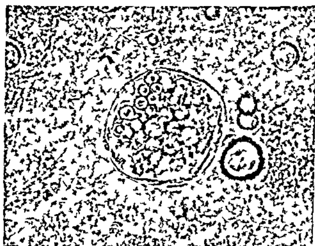


FIG 101 COCCIDIOIDES IMMITIS IN PUS × 400
(Courtesy of Dubos from Bacterial and Mycotic Diseases of Man J B Lippincott Co *1948 Page 618 Fig 71)*

cauliflower In a small number of cases the eye may become involved The bulbar, as well as the palpebral conjunctiva, may be affected The ear lesions resemble ordinary aural polyps The penile lesions resemble venereal warts which slowly change to cauliflower like growths Infections in the vagina and rectum resemble condylomata, hemorrhoids, or rectal polypi The disease is usually not fatal

Treatment The superficial and early lesions may be removed by careful dissection or electrodesiccation In the extensive cases pentavalent antimony is recommended as an adjunct to surgical measures

Coccidioides Immitis

This organism, which causes coccidioidomycosis was described

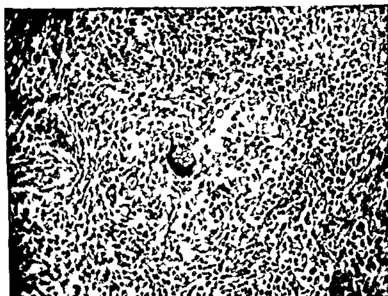


Fig 10? Coccidioides Immitis in Tissue × 200

first by Wernicke who reported it from Buenos Aires in 1891 Three years later Rixford reported from San Francisco the first case of it in this country Ophuls in 1900 reported the second case and suggested naming the organism Oidiumcoccidioides Since then numerous reports on it have appeared in the literature most of the cases occurring in California

MYCOLOGY

Microscopically, coccidioides immitis may be demonstrated in the pus of an unopened and uncontaminated lesion, occasionally it is demonstrable even in the discharges from opened

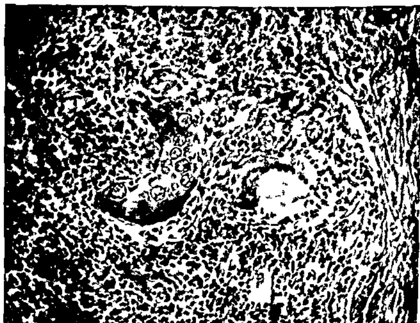


FIG 103 COCCIDIOIDES IMMITIS IN TISSUE × 400

and contaminated sinuses, ulcerations, and abscesses, and in sputum In pus, spinal fluid and tissue, it can be identified by *its characteristic spherical shape and double contoured* capsule, which varies in size from 5 to 60 microns The protoplasm is granular Under sufficient magnification, granules that have matured are seen to be exact replicas of the parent organism, appearing as a central deeply stained mass of protoplasm surrounded by a spherical double-contoured capsule In the tissue and pus reproduction takes place by endo poru

lation Jacobson states that he has seen evidence of budding Lactophenol-cotton blue or Mallory's eosin and methylene blue stain may be used the former stains the parasite blue the latter gives a blue protoplasm and a red capsule

Any of the sugar media is suitable for culture the medium of choice being Sabouraud's maltose peptone agar Although

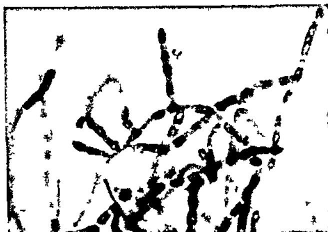


FIG 104 COCCIDIOIDES IMMITIS

Culture mount grown on Sabouraud's medium at room temperature showing thick walled arthrospores × 730 (Courtesy Dubos from Bacterial and Mycotic Diseases of Man J B Lippincott Co 1948 Page 617 Fig 70)

room temperature is usually sufficient growth is best under aerobic conditions and at body temperature It usually begins within ten days of planting The growth at first is moist and membranous but the colony soon develops an abundant cottony aerial mycelium which is white at first but becomes brownish with age On culture mount one sees branching septate hyphae which break up into thick walled arthrospores which may be rectangular ellipsoidal or spherical Animal inoculation is necessary for identification of the organism in its cultural form Laboratory workers should wear masks while

working with cultures of this micro organism since the arthro spores are highly infectious

ANIMAL INOCULATION

All laboratory animals are susceptible Guinea pigs and mice are most commonly used Aspirated pus from the in fected areas shows endospores surrounded by a spherical double contoured capsule

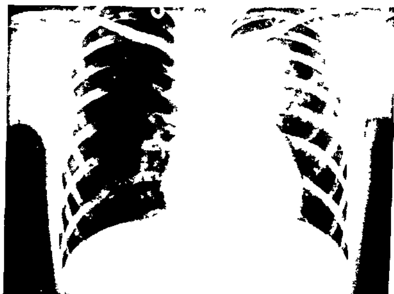


FIG 105 PULMONARY COCCIDIOIDOMYCOSIS SHOWING MASS WHICH WAS AT FIRST MISTAKEN FOR TUMOR OF THE LUNG

IMMUNOLOGIC REACTION

Although the reaction to coccidioidin is specific, it does not necessarily establish the diagnosis of any given infection, since the reaction may remain long after the infection has apparently subsided Lewis and Hopper tested 200 patients with no evi dence of coccidioidomycosis and found a negative reaction in 100 per cent The presence of agglutinins precipitins or com

plement fixation bodies in the blood of infected persons has not been definitely proved

CLINICAL MANIFESTATIONS

The disease appears to be especially prevalent among the working classes agricultural laborers and grape pickers are particularly susceptible Males are predominantly affected the highest incidence being between the ages of 20 and 45 although no age group is immune The majority of cases originate in the San Joaquin Valley and Los Angeles County California Scattered cases have been reported in the Middle and Southern States One of the authors (J H S) has recently seen a case originating in Arizona This patient has never lived in California

There are two stages the acute phase known as valley fever and that of chronic or coccidioidal granuloma Primary infection by way of the respiratory tract is common usually resulting from inhalation of dust containing the fungus The symptoms of primary pulmonary coccidioidomycosis resemble those of a mild upper respiratory infection although at times the onset is marked by malaise chills fever anorexia cough headache backache night sweats and pleuritis Chest signs are not usually present except in the more severe cases In such cases there may be dullness and suppressed breathing sounds and rales The roentgenogram of the chest may show soft fuzzy hilar thickenings pneumonic type of infiltration isolated nodular lesions in the parenchyma of the lung or small pleural effusions More than one of the above types of findings may be seen in a single patient The incubation period lasts from eight to fourteen days sensitivity to the fungus usually developing within a period of from three to twenty-one days Hypersensitivity is manifested by the appearance of erythema nodosum or erythema multiforme This acute form of the infection known as valley fever San Joaquin fever, or desert rheumatism subsides without complications The secondary

phase—coccidioidal granuloma—develops by dissemination from the primary focus either at the time of or after the initial infection Symptoms during this phase are indistinguishable from those of tuberculosis and lesions may appear in the skin, bones, joints lymph nodes, lungs, larynx, adrenals, and else



FIG 106 CHROMOBLASTOMYCOSIS BODIES IN TISSUE × 875
(Courtesy of Conant et al Manual of Clinical Mycology W B Saunders Co 1944 Page 99 Fig 51)

where except the intestines This phase of the disease is almost always fatal

Cutaneous Coccidioidomycosis The cutaneous and subcutaneous lesions may be primary or secondary and may take any of several forms They may appear as ulcerative nodules arising in the epidermis and extending later to subcutaneous tissue or they may arise in the latter They may simulate deep ab-

scesses, tuberculous lesions or gummata of the skin Still another type is the soft elastic flesh colored flaccid tumor that seldom ulcerates There is al o observed a scrofulodermatous lesion that originates in the superficial lymph nodes and is most frequently found in the supraclavicular region and elsewhere in the neck



FIG 107 HORMODENDRUM PEDROSOI PHIALOPHORA TYPE

Osseous Coccidioidomycosis Primary involvement is rare In the systemic cases however, secondary osseous invasion is frequent The most commonly affected parts are the bones of the foot, the ankle joint ribs, and vertebral column The

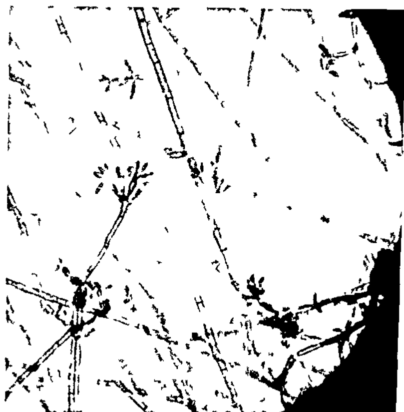


FIG 108 HORMODENDRUM PEDROSOI HORMODENDRUM TYPE

process usually takes a destructive, osteomyelitic form In the late stages bone proliferation is present

Cerebrospinal Coccidioidomycosis This is usually a terminal phase of the systemic form of the disease It is so varied both in nature and extent that the physician is confronted with a clinical picture ranging from that of a cerebral or spinal neoplasm to that of an epidemic or other form of meningitis

TREATMENT

No specific treatment has been evolved In the *primary pulmonary* type the object of treatment is to afford the patient



FIG 109 HORMODENDRUM PEDROSOI ACROTHECA TYPE

optimum condition for localizing the infection Rest in bed is necessary until the temperature white-cell count and sedimentation rate are normal and the pulmonary lesions have regressed completely or become stationary Symptomatic treatment such as salicylates with or without codein may be administered Supportive treatment is essential The variety of drugs used in the past including the more recently tried *sulfonamides* and *penicillin* have not proved too effective in the treatment of the *granulomatous* or *progressive* type *Vaccinotherapy* has been described as effective but the reports are few *Roentgen ray* treatment gives temporary relief *Iodides* are of



FIG 108 HORMODENDRUM PEDROSOI HORMODENDRUM TYPE

process usually takes a destructive, osteomyelitic form In the late stages bone proliferation is present

Cerebrospinal Coccidioidomycosis This is usually a terminal phase of the systemic form of the disease It is so varied both in nature and extent, that the physician is confronted with a clinical picture ranging from that of a cerebral or spinal neoplasm to that of an epidemic or other form of meningitis

TREATMENT

No specific treatment has been evolved In the *primary pulmonary* type the object of treatment is to afford the patient



FIG 111 HORMODENDRUM COMPACTUM × 816

(Courtesy of Zinsser Textbook of Bacteriology Appleton Century and Crafts New York 1948 Page 8 7 Fig 714)

CHROMOBLASTOMYCETIC FUNGI

The following are the organisms chiefly identified with the disease known as chromoblastomycosis

- Phialophora verrucosa
- Hormodendrum pedrosoi
- Hormodendrum langeroni
- Hormodendrum compactum

These organisms are the chief among the twenty-eight different fungi that have been described as causing the disease

MYCOLOGY

The above-mentioned causative micro-organisms produce identical forms in tissue On direct microscopic examination

questionable efficacy In some cases, the therapeutic use of certain drugs is helpful *Colloidal copper* may be administered intramuscularly in doses of 5 cc every four to seven days *Gentian violet* can be given locally in a 1 per cent aqueous solution or intravenously in a 0 25 per cent solution Since this drug is toxic no total dose greater than 5 mg of the drug per kilogram of body weight should be given *Antimony* and *potassium tartrate* in a 1 per cent solution may be administered intravenously in doses of 2 to 8 cc *Thymol* dissolved in olive oil, dispensed in capsule form is given in daily doses of 1 to 6 Gm Locally this remedy is applied as a 33⅓ per cent solution in olive oil

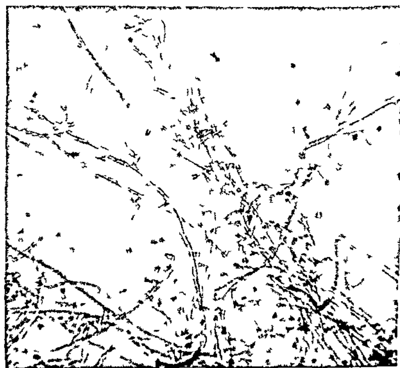


FIG 110 PHIALOPHORA VERRUCOSA



FIG 111 HORMODENDRUM COMPACTUM × 816

(Courtesy of Zinsser Textbook of Bacteriology Appleton Century and Crafts New York 1948 Page 87 Fig 214)

CHROMOBLASTOMYCETIC FUNGI

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Hormodendrum pedrosoi
Hormodendrum langeroni
Hormodendrum compactum

These organisms are the chief among the twenty-eight different fungi that have been described as causing the disease

MYCOLOGY

The above-mentioned causative micro-organisms produce identical forms in tissue On direct microscopic examination



FIG 112 CHROMOBLASTOMYCOSIS
(Courtesy of Martin et al Am J Trop Med 16 1936 Plate 1)

of the pus and tissue, brown thick walled uni- to multilocular cells are found In old necrotic lesions filaments may be seen On Sabouraud's agar, the colonies are dark green to black, velvety, and show aerial mycelium and concentric rings

CLINICAL MANIFESTATIONS

At onset, the eruption in chromoblastomycosis takes the form of reddish, purplish, or brownish nodules or appears as a

deep verrucous or ulcerative lesion After many months or years the nonverrucous nodules coalesce and become verrucous forming large cauliflower tumors Secondary pyogenic infection takes place A foul discharge is present Healing results in scarring Nonwarty and nonulcerative lesions have also been reported The most common sites of the eruption are the lower extremities although the upper extremities, face and buttocks have been reported involved Adenopathy is infrequent except when secondary pyogenic infection is present The picture can simulate that of blastomycosis tuberculosis verrucosa cutis, psoriasis and discoid lupus erythematosus No instances of internal metastasis have been reported Weidman states that the infection is usually of exogenous origin and spreads by extension

TREATMENT

Administration of large doses of iodides in combination with roentgen rays has been reported as the most successful therapeutic measure In localized involvement electrodesiccation and curettage are worth trying Martin and his associates treated one patient with copper sulfate administered by means of iontophoresis and obtained good results after five months They used a 1 per cent solution and a galvanic current of 2 5 milliamperes for thirty minutes Daily treatment was administered After nine weeks the current was increased to 10 milliamperes

SPOROTRICHUM

Numerous species of Sporotrichum are common saprophytes found in all parts of the world on many types of vegetation and in human and animal excreta In this country, the chief cause of sporotrichosis is Sporotrichum schencki (1910) This organism is pathogenic in such animals as horse and mules while rats are particularly susceptible For laboratory purposes the white rat is used

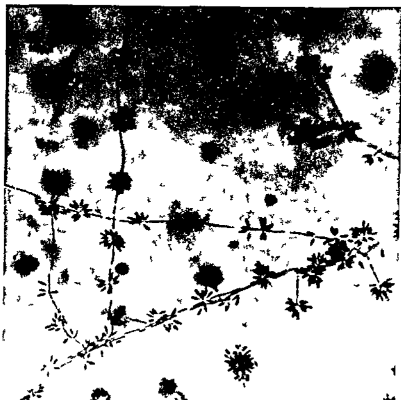


FIG 113 SPOROTRICHOSIS
Culture mount of causal organism showing pear shaped pores attached to hort stalk and to mycelium

MYCOLOGY

It is very difficult to demonstrate the organism in fresh preparations Lawless uses a stain by which the spores become demonstrable in fresh pus

The colony grows well on most laboratory media at room temperature On dextrose agar a recognizable growth is obtained in about five to seven days The 2 week old colony is about 2 5 cm in diameter, moist and characterized by irregular central convolutions At first the border is smooth,



FIG 114 LYMPHANGITI SPOROTRICHOSI (PROVED CASE)

later becoming ridged A light brown at two weeks the color darkens except for white surface excrescences to brownish black this is an important feature This characteristic hue is doubtless derived from the spores that darken to a brown or black as the colony ages Pear shaped conidia attached to conidiophores and appearing in triads and tetrads are characteristic

CLINICAL MANIFESTATIONS

Sporotrichosis appears in several different forms

Lymphangitic Type This is the most common form in this country It consists in a primary lesion usually on the fingers or the hand this is at first indurated then softens breaking

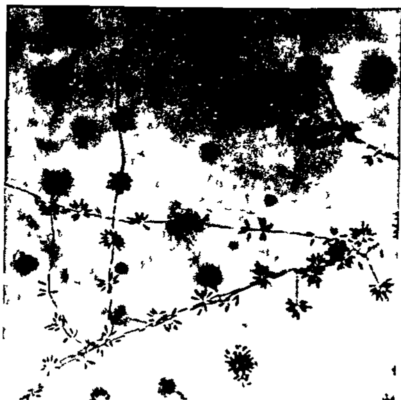


FIG 113 SPOROTRICHOSIS
Culture mount of causal organism showing pear shaped spores attached to short stalk and to mycelium

MYCOLOGY

It is very difficult to demonstrate the organism in fresh preparations I awless uses a stain by which the spores become demonstrable in fresh pus

The colony grows well on most laboratory media at room temperature On dextrose agar a recognizable growth is obtained in about five to seven days The 2 week old colony is about 2 5 cm in diameter moist and characterized by irregular central convolutions At first the border is smooth,

Involution leaves soft pliable scars on the surface of which the Sporotricha subsist as saprophytes making a carrier of the host

2 *Muscular and Glandular Involvement* This is usually associated with the cutaneous type of infection The lesions are characteristically gummatous or simulate the so-called cold abscess

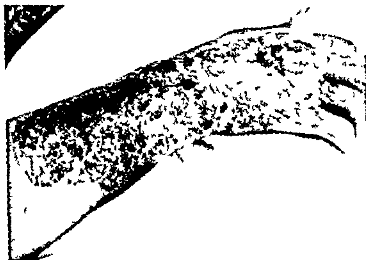


Fig 116 Eczematous Sporotrichosis (Proved Case)

3 *Osteo-articular Involvement* This may be primary, or it may be secondary to a cutaneous or mucous membrane infection The osseous involvement may be brought about either by direct extension or by metastasis through the blood stream

4 *Articular and Synovial Membrane Involvement* This is not common

5 *Epididymal Involvement* This is more frequently seen in laboratory animals than in human clinical manifestations

down and forming an abscess This lesion is frequently called *sporotrichotic chancre* A week or more later, hard nodules, which later break down, appear along the course of the regional lymphatics Enlargement of regional lymph nodes is rare Spontaneous involution of the lesion is not common, and interference is usually necessary

Other forms manifest *solitary subcutaneous gummatous*



FIG 115 SPOROTRICHOSIS

lesions, or *disseminated subcutaneous gummatous* lesions, with ulceration, or *mixed* lesions that may simulate those of tuberculosis syphilis, ecthyma, and furunculosis Associated involvement of the bones, joints, mucous membranes, muscles, and eyes may be present

The *systemic* phase of the disease may take one form or may represent a combination of the following

1 *Mucous Membrane Involvement* Lesions of the cutaneous type appear, involving the conjunctivae and the linings of the nose tongue, pharynx mouth larynx and intestinal tract

Involution leaves soft pliable scars on the surface of which the Sporotricha subsist as saprophytes making a carrier of the host

2 *Muscular and Glandular Involvement* This is usually associated with the cutaneous type of infection The lesions are characteristically gummatous or simulate the so-called cold abscess

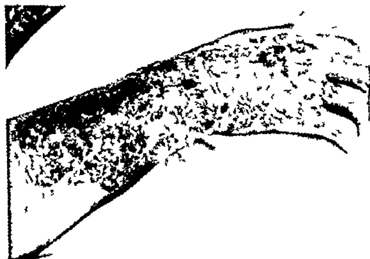


FIG 116 ECZEMATOUS SPOROTRICHOSIS (PROVED CASE)

3 *Osteo-articular Involvement* This may be primary or it may be secondary to a cutaneous or mucous membrane infection The osseous involvement may be brought about either by direct extension or by metastasis through the blood stream

4 *Articular and Synovial Membrane Involvement* This is not common

5 *Epididymal Involvement* This is more frequently seen in laboratory animals than in human clinical manifestations

6 *Pulmonary Involvement* Differentiation between this picture and that of tuberculosis, syphilis, and malignant disease is made by laboratory studies

7 *Gastro intestinal Involvement* Extremely rare this can be diagnosed on the basis of examination and culture of the stools

8 *Cerebrospinal Involvement* Extremely rare, this is diagnosed chiefly by the finding of Sporotricha in the spinal fluid

Allergic lesions (*sporotrichids*), comparable to trichophytids, have been described by De Beurmann

IMMUNOLOGIC REACTION

De Beurmann, Moore, and Davis state that agglutination reactions are usually demonstrable Bloch and De Beurmann believe that the intracutaneous test with an extract of Sporotrichum has value A negative reaction rules out the diagnosis of sporotrichosis One must be on the alert, however for the occasional false positive reaction

TREATMENT

Iodide is the most effective weapon in the treatment of this disease It is administered as potassium iodide in milk or water orally beginning with 10 drops of a saturated solution three times a day and increasing by 3 to 5 drops per dose daily until intolerance is reached This treatment should be continued for at least one or two months after apparent complete recovery If this drug is not tolerated orally sodium iodide in daily doses of 1 Gm may be given intravenously In the rapidly spreading or fulminating type and in systemic sporotrichosis it is wise to administer potassium iodide orally and ethyl iodide by inhalation (The technic and dose are described in the section on moniliasis, p 53)

Another method of iodide therapy is by iontophoresis de-

scribed by Shaffer and his associates This treatment is given daily for a period of thirteen weeks They recommend a strong solution of iodine U S P diluted 1 100 in isotonic solution of sodium chloride and increased to 1 50 after seven weeks Since the active ion, iodine is an anion the negative electrode is attached to the involved parts and the indifferent positive electrode is placed on the back They recommend a current of about 15 milliamperes for twenty minutes in the first week and gradually increased to about 35 milliamperes for thirty minutes

Roentgen ray therapy is indirectly effective because of its action on granulomatous tissue It is a poor fungicide

Surgery is the method of choice only if fluctuation is present when it may be necessary to resort to incision and drainage

Local application may be made of gentian violet (1 to 2 per cent) potassium permanganate (1 100 or 1 200), or the following ointment

		Gm or cc
℞	Mercurochrome crystals	0 6–1 2
	Aquae	1 2
	Acidi salicylici	2 0
	Petrolati	
	Lanolini āā ad	30 0
ℳ		

Recently good results have been reported in a few instances from the use of *sulfonamides* but this method of treatment requires further confirmation *Penicillin* and *streptomycin* have not produced good therapeutic results in this disease

Although sometimes helpful the measures described are far from curative in systemic cases

ACTINOMYCES

Although chiefly Actinomyces bovis is discussed here other species have been reported as pathogens

MYCOLOGY

Actinomyces bovis (Hartz, Wolf and Israel) is the chief cause of actinomycosis Frequently referred to as ray fungus, the micro-organism appears in the pus from draining fistulas

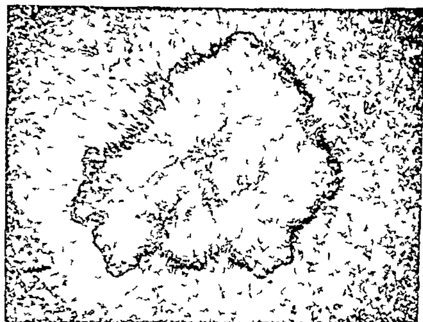


FIG 117 SULFUR GRANULE IN PUS × 450
(Courtesy of Conant et al Manual of Clinical Mycology W B Saunders Co 1944 Page 11 Fig 7 A)

as small granules, hyaline to sulfur yellow in color, made up of a tangled mass of mycelium with a lobulated border that may or may not have radially arranged clubs When crushed between two slides the granules break up into short branching mycelial elements that are gram positive when stained In sputum or spinal fluid, organized granules may not be found, but especially in the presence of tuberculosis like lesions and

when acid fast bacilli are absent, gram positive branching hyphae should be suspected as suggesting Actinomyces



FIG 118 ACTINOMYCES BOVI × 850 (FROM DEEP SHAKE TUBE IN CULTURE) (Courtesy of Conant et al Manual of Clinical Mycology W B Saunders Co 1944 Page 14 Fig 9B)

On deep meat infusion agar incubated at 37 C the culture will produce colonies in three or four days These appear as small white fuzzy or lobulated growths from 3 to 4 mm below the surface of the agar Deeper in the tube may be seen large white loculated colonies Transplants may grow aerobically

Microscopic examination of a culture mount does not disclose any characteristic structures The only findings are interlacing hyphae

Actinomyces (Nocardia) asteroides The colonies on Sabouraud s glucose agar slants grown at room temperature or at

37 C show a surface growth which is glabrous, irregularly folded and vary in color from pale yellow to deep orange

Actinomyces (Nocardia) gypsoides The colonies on Sa



FIG 119 ACTINOMYCOSIS
Causal organism (ray fungus) in tissue

bouraud's glucose agar slants grown at room temperature or at 37 C are chalky white

Actinomyces (Nocardia) madurae The colonies grown aerobically on Sabouraud s glucose agar at room temperature or at 37 C show a glabrous, waxy, wrinkled cream colored colony With age, the colonies appear pinkish to varying shades of red

The microscopic examination of a culture mount of any of the above species of Nocardia shows delicate branching hyphae



Fig 120 Actinomycosis
(Courtesy of N F Conant)

IMMUNOLOGIC REACTION

Agglutination reactions are usually positive but scarcely practical Cutaneous hypersensitivity to vaccine in patients with the infection has been reported

37 C show a surface growth which is glabrous, irregularly folded and vary in color from pale yellow to deep orange

Actinomyces (Nocardia) gypsoides The colonies on Sa



FIG 119 ACTINOMYCOSIS
Causal organism (ray fungus) in tissue

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The microscopic examination of a culture mount of any of the above species of Nocardia shows delicate branching hyphae

surrounding skin is usually infiltrated and boardlike to the touch

Actinomycosis of the cutaneous and subcutaneous tissue may be confused with syphilitic gumma tuberculosis coccidioidal granuloma sporotrichosis and carcinoma The differential



Fig 1?1 Actinomycosis

points distinguishing actinomycosis are multiple abscesses discharging sulfur granules sinuses and fistulas with or without fungating granulation tissue masses surrounded by a boardlike induration

Visceral Manifestations The various forms are as follows

Lingual actinomycosis is rare in man more commonly affecting cattle hogs and other domestic animals In man it may

CLINICAL MANIFESTATIONS

Almost no tissue or organ escapes According to Sanford and Voelker, 60 per cent of cases occurring in this country show involvement of the head and neck, 18 per cent are abdominal, 14 per cent are thoracic, 8 per cent show involvement of other organs, including the cutaneous and subcutaneous tissues The infection may spread by extension or by way of the blood stream

The clinical manifestations are (1) cutaneous, and (2) visceral

Cutaneous Manifestations Although sometimes primary, cutaneous involvement is as a rule secondary to a more deep seated process In head and neck involvement, the primary lesion may often be found in the buccal mucous membrane The gums, the tonsillar crypts or other parts of the mouth may be involved The initial sign of *primary* cutaneous involvement is usually a solitary nodule in the epidermic layers, the corium and subcutaneous layers showing invasion next by extension The nodules enlarge gradually, soften and finally rupture The discharge is serous, purulent, or sanguineous and contains the characteristic sulfur yellow granules The primary nodule, after breaking down, forms an ulcer and either heals spontaneously, leaving an atrophic pigmented scar or continues as a crusted discharging lesion New nodules develop adjacent to the primary nodule and eventually coalesce, each passing through the same development as did the primary lesion

The lesions of *secondary* cutaneous involvement are primarily subcutaneous, involving the cutaneous tissue by extension upward They take the form of deep seated nodules or tumors of varying sizes, fairly firm to the touch and of a livid hue They soon break down and develop multiple intercommunicating sinuses that discharge a seropurulent or sanguineopurulent fluid containing the characteristic sulfur yellow granules The

due to extension or infection by way of the blood stream There is no characteristic clinical picture on the basis of which diagnosis can be made A helpful indication is involvement of the bases of the lungs as shown on roentgenologic examination



FIG 123 ACTINOMYCOSIS OF CHEST WALL BEFORE TAPPING
(Courtesy of I L Robbins)

X ray examination shows smooth irregular massive areas of consolidation without cavity formation most often in the lower lobes and usually bilateral In advanced cases the pleura may show either massive adhesions or massive accumulation of fluid which may or may not be encapsulated The ribs may show both destructive and proliferative changes

be primary or secondary to involvement of the buccal or pharyngeal cavities The first sign is a small deep seated nodule in the body of the tongue This enlarges, softens, and finally ruptures, discharging pus that contains the typical sulfur granules New nodules form elsewhere in the tongue or neighboring on the initial nodule and undergo the same pro



FIG 122 PULMONARY ACTINOMYCOSIS
(Courtesy of L L Robbins)

gressive changes At first no discomfort is present with enlargement of the nodule, however, the mucous membrane over lying it is stretched, and the pain thus caused is not relieved until the abscess ruptures

Pulmonary actinomycosis is rarely primary, most cases are

ductive organs may also be invaded In urinary tract infection the symptoms simulate those of pyelonephritis cystitis hypernephroma carcinoma or sarcoma In most of these cases diagnosis is not established until surgical exploration or autopsy is made

Cerebrospinal involvement is rare and fatal The picture may simulate that of meningococcus or tuberculous meningitis

Osseous involvement is the rarest form of ray fungus infection in man In cattle on the other hand, it is common In the few recorded cases of osseous involvement in man the bones invaded were those of the vertebral column

TREATMENT

The response to treatment even in the most auspicious cases is slow The choice of treatment should depend upon the location type duration extent and severity of the lesion For the primary cutaneous type the administration of sulfonamide or penicillin supplemented by one or a combination of the old mainstays mentioned below is usually sufficient For the extensive cases and the systemic type combined therapy using sulfadiazine penicillin plus the old mainstays such as irradiation give the best results In all extensive and systemic cases general hygienic measures a high-calorie and high vitamin intake bed rest iron and liver extract are essential

Penicillin 50 000 units is administered intramuscularly every three hours to a total of at least 6 000 000 units In cases of central nervous system involvement, well-diluted penicillin can be given intrathecally (50 000 units daily)

Sulfadiazine There is ample evidence that the sulfonamides are useful agents in the treatment of this disease Sulfadiazine is recommended because of its low toxicity The initial dose is 2 Gm and then 1 Gm every four hours until the patient appears to be clinically well For prophylactic reasons the sulfonamide should be continued in doses of 1 Gm four times



FIG 124 ACTINOMYCOSIS OF CHEST WALL AFTER TAPPING
(Courtesy of L. L. Robbins)

The most important diagnostic criterion is the presence of the ray fungi in the sputum

Intestinal actinomycosis is characteristically found, when primary in the region of the cecum and appendix Depending on the onset, the course may be chronic or acute In the latter instance the picture may simulate acute appendicitis The chronic form of the infection sometimes becomes extensive, involving many of the abdominal organs before diagnosis is made Extension of the process through Scarpa's triangle and into the hip joint has been known to occur The female repro-

Lugol s solution or with 1 per cent gentian violet has been advocated

Streptomycin has not been used in enough cases of actinomycosis to evaluate its therapeutic index in this disease Costigan reports cure of a severe case of actinomycosis within five days after institution of treatment with streptomycin 250,000 units in 2 5 cc of sterile water every three hours The same patient did not respond to iodides, penicillin and sulfonamides

Vaccine therapy has been used with some success as a supplement to surgery and to penicillin and sulfonamide treatment Colebrook recommends both stock and autogenous vaccine in doses of 5 000 000 to 10 000 000 mycelial fragments at intervals of five days

NOCARDIOSIS

Actinomycosis caused by certain strains of aerobic actinomycetes is known as *Nocardiosis* The micro-organisms are better known as Nocardia The clinical manifestations may be indistinguishable from those found in actinomycosis caused by A bovis The Nocardia are partially acid fast gram positive and occur as branching forms both in the tissue and in culture

TRICHOMYCOSIS AXILLARIS ACTINOMYCES

The causative micro organism in trichomycosis axillaris is believed by Castellani to be Actinomyces tenuis Associated micrococci are responsible for the formation of the various pigments

Weidman reproduced the disease on the hair of the face and axillae in a monkey by feeding the animal a species of Actinomyces that he isolated from a black hairy tongue The axillary hairs show the presence of firmly attached yellow red or black concretions The yellow and red varieties are those most frequently found in this part of the country

daily, gradually reduced to 3 Gm and 2 Gm daily *for a period* of several months If any signs of relapse are noticed, intensive therapy should be resumed Sodium bicarbonate should be prescribed to be taken simultaneously The urine and blood should be examined at first once a week for one month and then about once every two weeks

Roentgen ray therapy is a useful supplementary treatment especially in cases of indolent lesions Good results have been reported with fractional and intensive therapy, with and without filtration

Surgery should be postponed until after several doses of sulfonamide *or penicillin have been administered wherever* practical Adequate surgical drainage is important Localized accessible lesions may be completely excised

Iodides as a supplementary treatment may be given as a saturated solution of potassium iodide starting with 15 drops three times a day orally, and increasing 3 drops daily to the point of tolerance Tincture of iodine in milk or water, starting with 5 drops three times a day and increasing the dose until symptoms of intolerance develop, is another form of iodine therapy Sodium iodide may be administered intravenously in 1 Gm doses once a day in place of potassium iodide Ethyl iodide inhalation therapy is of particular value in cases of bronchopulmonary involvement The initial dose is 1 5 cc (3 Gm), this is increased by 0 5 cc (1 Gm) per dose until 4 cc (8 Gm) is reached Inhalations are given on two successive days and *omitted on the third day* A *discussion of contraindications* and possible complications will be found in the section on moniliasis, Chapter III, p 54

Thymol given locally (10 to 20 per cent solution in olive oil) and systemically (capsules of 1 to 2 Gm by mouth once a day) has been reported as successfully employed

Copper sulfate (1/4 gr) given by mouth, or colloidal copper administered intravenously, has been used

Local treatment by irrigation with penicillin, a diluted

Actinomyces Minutissimus

Synonym Microsporum minutissimum

Little is known about the cultural properties of this organism because of the difficulty of securing cultures It causes the disease known as erythrasma

Mycology

On direct microscopic examination of the cutaneous scales treated with potassium hydroxide, and using the oil immersion lens, fine threadlike structures can be made out

Clinical Manifestations

The eruption is macular and covered with a fine scale Its color is almost identical with that seen in tinea versicolor, varying from yellowish brown to dull red The areas of predilection are the axillae and groins Other folds of the skin may be involved

Treatment

A daily bath, followed by the application of the following ointment, is advised

		Gm or cc
℞	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0
♍		

A 25 per cent solution of sodium hyposulfite may be used instead of the ointment above indicated

Underclothing must be boiled in addition to being washed

Treatment should be maintained for at least one week after all signs of activity are gone

Maduromycetic Fungi

A number of fungi have been described as capable of causing

Shaving the hairs, and use of the following ointment, which loosens the concretions and acts as a fungicide, are of value

		Gm or cc
℞	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0
M		

Trichosporum Hortai

MYCOLOGY

This micro-organism is the cause of tinea nodosa (Piedra), the black node type On direct microscopic examination of a severed node one notes branched and septate hyphae Asci containing two to eight spores may be seen in such preparations The colony is glabrous and black and in culture mount one sees chlamydospores and asci

Trichosporum Giganteum

This fungus is considered responsible for the white node type of tinea nodosa On direct microscopic examination of a severed node, one sees hyphae and an occasional budding cell The colony is moist and yellow

CLINICAL PICTURE

Piedra is a disease characterized by the presence of nodes varying in color from light brown to black As many as twenty five nodes may be present on a single hair In South America, it is seen on the scalps of women, whereas in Europe and Asia the moustache and beard of men are affected

Treatment (1) Shaving This is important and may be all that is necessary to effect a cure (2) Thorough shampoo, followed by the application of bichloride of mercury solution (1 2 000)

as a subcutaneous swelling that extends to the surface and ruptures discharging a seropurulent fluid containing yellowish reddish, or blackish granules Sinus tracts form burrowing



FIG 176 MADUROMYCOSIS OF THE FOOT CAUSED BY MONOSPORIUM APIOSPERMUM
(Courtesy of N F Conant)

and extending to the deeper structures eventually causing malformation Constitutional symptoms are slight

TREATMENT

Iodides combined with roentgen ray therapy may be helpful provided treatment is begun early Sulfonamides and penicillin are useful in taking care of the usually present superimposed bacterial infection which is frequently the cause of death These drugs may also be effective if the causal micro-organism is a species of Actinomyces The dosage and the course of treatment are discussed in the section on actinomycosis p 192

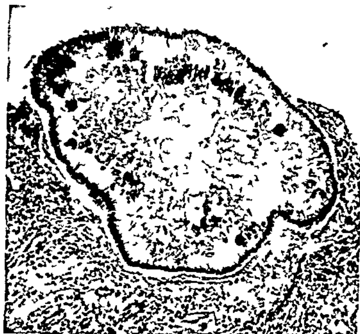


FIG 125 MADUROMYCOSIS GRANULE IN TISSUE × 112 MONOSPORIUM APIOSPERMUM CULTURED

(Courtesy of Smith Fungus Disease Encountered in General Hospital Practice Am J Med 3 602 Fig 8)

the disease known as mycetoma (maduromycosis) The following are some of the alleged causative micro-organisms Actinomyces, Madurella Indiella, Glenospora, Monosporium Aspergillus, and Penicillium The disease is endemic in India, especially in the city of Madura, from which the name maduromycosis is derived It is not common in the United States All age groups beyond the period of puberty are liable The disease is more common in males, especially in field hands who habitually go barefoot

CLINICAL MANIFESTATIONS

The site of infection is the foot, where the initial sign appears



FIG 128 TINEA VERSICOLOR

lesions round and budding spores of varying size are seen clustered like bunches of grapes with usually short and at times curved mycelium In some preparations the mycelium is the predominating feature, in others the spores are the most prominent Routine cultures are not practical since failure to obtain growth is the rule Moore obtained cultural growth on different media after the initial isolation on maltose broth

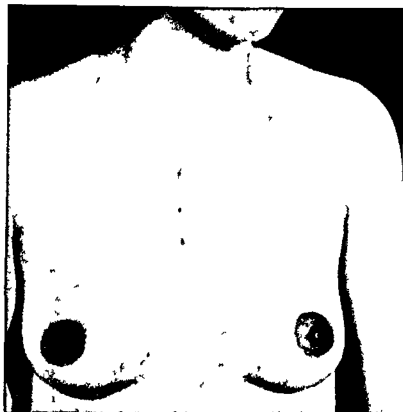


Fig 127 Tinea Versicolor

In cases where deformity and destruction have already become marked, amputation may be the only recourse

Malassezia Furfur

Synonym Microsporum furfur

This organism has not yet been definitely classified It is responsible for tinea versicolor (pityriasis versicolor)

MYCOLOGY

On direct microscopic examination of the scales from the

rays show fluorescence varying from golden yellow to dark brown

The areas of predilection are the anterior aspects of the



FIG 130 TINEA VERSICOLOR
Scales showing mycelium and grapelike clusters of fungus spores

thorax the upper back and the neck Occasionally the eruption extends to the abdomen and upper extremities Cases have been reported in which the axillae and groins have been involved The eruption is usually asymptomatic and lasts a long time when not treated

TREATMENT

A hot bath with scrubbing of the involved parts followed by the application of sodium hyposulfite solution (25 per cent) or the following ointment is advised



FIG 129 TINEA VERSICOLOR (ACHROMIA)

CLINICAL MANIFESTATIONS

The eruption in the disease is macular, showing a fine furfuraceous scaling and is usually a yellowish to dirty brown The scales vary from pinhead to coin size and may be discrete or coalescent After exposure to sun, the pigment may be lost and the eruption may have a vitiliginous appearance retaining the fine scale The depigmentation can be confused with achromia parasitica, tinea flava vitiligo pinta, and syphilitic leukoderma In rare cases follicular involvement may be present, the lesions remain small and may become papular Lesions of tinea versicolor examined under filtered ultraviolet

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		Gm or cc
℞	Acidi salicylici	2 0
	Sulphuris praecipitatis	2 0
	Petrolati	30 0
m̧		

This procedure is to be continued for a week after all clinical signs of the disease have disappeared The underclothing should be thoroughly washed and boiled, and changed daily

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CHAPTER VII

COMMON CONTAMINANTS AND PROBABLE PATHOGENS

THE ATMOSPHERE is so filled with common contaminants that they frequently crowd out pathogenic fungi much to the inconvenience of the laboratory investigator of these organisms In the laboratory they give even more trouble than the ordinary bacteria which do not grow well at room temperature

The common contaminants and probable pathogens include the following

Aspergillus	Mucor
Penicillium	Hormodendrum
Alternaria	Dematium
Scopulariopsis	Fusarium
Cephalosporium	Torula or Cryptococcus
Mycoderma (Geotrichum)	

Some of these organisms have already been discussed

ASPERGILLUS

The type species is Aspergillus glaucus It has a vegetative mycelium made up of septate branching hyphae These may be hyaline of bright hue or less commonly, brown The conidia arise from specialized oversized hyphal cells the stalks branching from these cells are septate or nonseptate and broaden into ellipsoid hemispherical or globose vesicles The latter show phialides, which may be parallel and clustered in terminal columns or may radiate from the whole surface The color shape and markings of the conidia show wide variety Septa cut them off successively from the sterigma tips the conidia being arranged in unbranched chains in a pattern of

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of the black grained type Aspergillus niger and its variants have been blamed for otomycosis but their pathogenicity is doubtful Scattered reports in the literature of various species of Aspergillus causing onychomycosis are found Bereston and Waring report 13 cases It is not doubted that the unusual can happen but when Aspergillus is the only micro-organism cultured from the diseased nails other causes such as systemic diseases must be considered Pure cultures of Aspergillus Penicillium Scopulariopsis and nonpathogenic yeasts have been grown from diseased nails associated with nutritional disturbances psoriasis and other diseases Even bronchitis and intrinsic asthma have been reported to be due to Aspergillus Care must be exercised to prove the pathogenicity of the micro-organism by recognized and accepted methods before it is accepted as a direct causative agent Koch s postulate applies here as elsewhere

Otomycosis

Various fungi have been blamed for this disease These include Monilia Aspergillus and Penicillium Aspergillus has been a common finding but autoinoculation experiments by Lewis and Hopper and others have not proved successful We believe that most cases of so-called otomycosis are caused by bacteria and other agents rather than by fungi The fungi found are saprophytes living under favorable conditions

CLINICAL MANIFESTATIONS

Various clinical pictures have been described as otomycosis The most commonly described findings are swelling and redness of the external ear a moist mass of cheesy debris completely filling the canal and exudative skin underlying the debris The disorder may extend all along the canal and involve the drum Claims of extension of the infection to the tympanic cavity and the mastoid cell in cases where perforation of the drum is present have been made Pruritus is a common and troublesome symptom

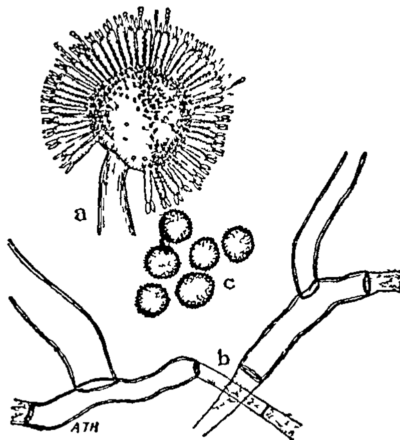


Fig 131 Aspergillus Niger
a = spore-bearing head b = mycelium c = spores (Bull 82 U S Department of Agriculture Bureau of Animal Industry)

radiate heads or in columnar masses Some species show perithecia that are thin walled and cleistocarpous and produce asci and ascospores within a few weeks Sclerotia, usually spherical or of subspherical shape and made up of thick walled cells, are characteristically found in some strains while absent in other closely related strains

A species related to A nidulans has been found in mycetomas

Treatment Iodide therapy has proved the most effective form of treatment It must not be administered in cases where pulmonary tuberculosis is suspected Bed rest wholesome food and fresh air are advisable

Penicillium Link

PENICILLIUM EXPANSUM LINK

Colonies of this organism vary in hue from green to hazel yellow red purple and other colors Conidiophores branch from the vegetative mycelium and may be single or branching The conidia show brush or broomlike patterning There is no vesicle The conidia vary in shape from cylindric to ovoid ellipsoid or in the final form a spherical conformation They may be smooth or rough

ALTERNARIA

The colonies have a dark olive green or brown woolly surface The spores are large made up of a number of cells, and multichambered They appear in chains sometimes separated by short stretches of mycelium Most of the species are plant pathogens

Scopulariopsis

Originally included in the genus Penicillium this group shows Penicillium like branching except that it is irregular The conidiophores may even be unbranched The terminal branches forming the spores may not show the characteristic apical constriction to a narrow tubular process that is seen in Penicillium The conidia are large thick walled spiny and constricted at their bases

The best known species is Scopulariopsis brevicaulis which has been reported as having been isolated from lesions of onychomycosis and from gumma like masses Its pathogenicity however is questionable Characteristic of it are the pale *yellow* conidia

Treatment In the few proved cases the treatment is directed toward frequent removal of the debris followed by the application of suitable local treatment A mixture of saturated solution of boric acid, three parts, and alcohol (70 per cent), one part, is used for swabbing involved areas after removal of the debris This is followed by the application of either a 5 per cent mercurochrome solution or a 1 per cent bacterial fuchsine solution Metacresyl acetate (cresatin) may be used in place of the mercurochrome or bacterial fuchsine solutions Roentgen ray treatment in fractional doses may help relieve the pruritis

PULMONARY ASPERGILLOSIS

Of all cases reported only a few were proved Aspergillus fumigatus and Aspergillus niger were the chief causative species This infection is more frequent in bird fanciers, grain dealers, and wheat threshers Pigeons, parrots, and other birds are considered the medium of exposure A worth while precautionary measure is the wearing of a gauze mask by grain threshers

CLINICAL MANIFESTATIONS

Primary infections with Aspergillus are rare The symptoms are similar to those of pulmonary tuberculosis Cough is present The sputum is mucoid or muco purulent and frequently contains blood The general health of the patient may not be affected seriously or there may be remittent fever, loss of weight, obvious toxemia cachexia and death The physical findings are usually indistinguishable from those of chronic pulmonary tuberculosis Aspergillosis may occur as a secondary infection in tuberculosis bronchiectasis and carcinoma of the lungs Before diagnosis of primary pulmonary aspergillosis is made, other diseases of the lungs must be excluded and cultures of the micro-organism in multiple colonies must be repeatedly demonstrated

Treatment Iodide therapy has proved the most effective form of treatment It must not be administered in cases where pulmonary tuberculosis is suspected Bed rest wholesome food and fresh air are advisable

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Alternaria

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Fig 132 Penicillium
Conidiophores and conidia resembling whisk broom

Cephalosporium

CEPHALOSPORIUM ACREMONIUM CORDA

The colony changes from its initial white hue to rose color The conidiophores are not branched and their tips are not swollen The conidia arise at the tips and though pushed aside

by subsequent conidia, cling together forming a spherical mass This species is a common laboratory contaminant

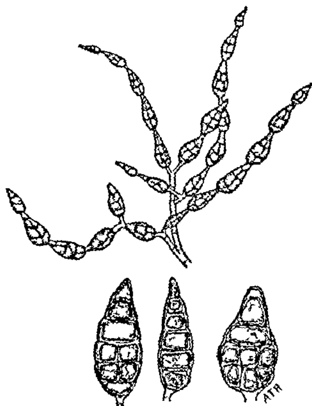


FIG 133 ALTERNARIA CHAINS OF FUSEAUX
(Bull 87 U S Department of Agriculture Bureau of Animal Industry)

GEOTRICHUM LINK

GEOTRICHUM CANDIDUM LINK

The colonies are velvety dull membranous and adhere to the substratum They form a pellicle on liquid media and liquefy gelatin but they do not ferment sugars

Microscopic examination of cultural mounts shows septate mycelium, arthrospores with both abrupt and rounded ends, and small round blastophores The conidia like cells are both round and pyriform

Geotrichum is sometimes classified apart from Mycoderma on the ground that the latter shows more complete gelation of



FIG 134 SCOPULARIOPSIS MYCELIUM AND CONIDIA

the walls This is not sufficient reason The terms should be synonymous and the organisms called Mycoderma should be classified as variants of Geotrichum

This organism, found in human sputum and excreta is considered a nonpathogen It may ultimately prove to be both a

saprophyte and a pathogen The author has found a high incidence of Geotrichum Link in ulcerative colitis

This micro-organism has been reported the cause of oral geotrichosis This infection is characterized by white patches in the mouth indistinguishable clinically from thrush caused

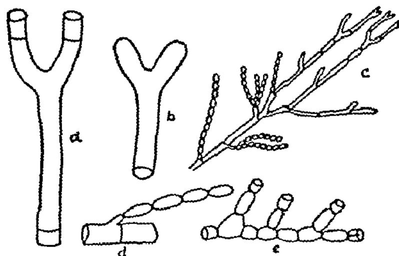


FIG 135 OIDIUM

a b = dichotomous method of branching *c d e* = chains of spores (Bull 8? U S Department of Agriculture Bureau of Animal Industry)

by candida albicans Bronchial and pulmonary geotrichosis have been reported Except for the repeated cultivation of the micro-organism from the sputum one cannot clinically differentiate pulmonary geotrichosis from other diseases of the lung Like pulmonary aspergillosis this condition may be superimposed upon other pulmonary diseases

Iodide therapy is effective in all forms of geotrichosis The method of administration is the same as that described for the treatment of moniliasis Rest in bed and a high vitamin intake

Microscopic examination of cultural mounts shows septate mycelium, arthrospores with both abrupt and rounded ends, and small round blastophores. *The conidia like cells are both* round and pyriform.

Geotrichum is sometimes classified apart from Mycoderma on the ground that the latter shows more complete gelation of



FIG 134 SCOPULARIOPSIS MYCELIUM AND CONIDIA

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This organism, found in human sputum and excreta, is considered a nonpathogen. It may ultimately prove to be both a

that in a chain the one farthest from the conidiophore is the youngest This affords a sharp contrast to the spore arrangement in Aspergillus and Penicillium in which the terminal spore in a chain is the oldest In Hormodendrum a spore may develop more than one new spore simultaneously thus causing the chains of conidia themselves to branch

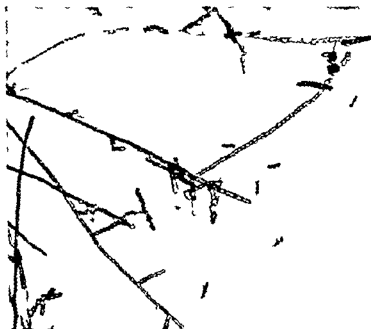


FIG 137 HORMODENDRUM

DEMATIUM

DEMATIUM ARTICULATUM PERSOON

This species is parasitic or saprophytic on plants The hyphae are septate and branched with chains of smooth black arthro pores on lateral branches

are essential Oral geotrichosis may be treated with sodium perborate (3 drachms to ½ glass water) as a mouth wash Gentian violet, 0 5 to 1 per cent aqueous solution painted on the involved areas may prove effective

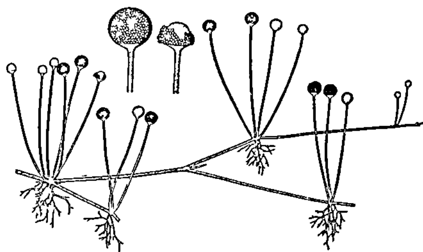


Fig 136 Rhyzopus Nigricans (Bread Mold)
(Bull 82 U S Department of Agriculture Bureau of Animal Industry)

Mucor

This is one of the members of the family Mucoraceae These are a group of molds, frequently referred to as the bread mold and belonging to the order Phycomycetes They are also found abundantly in soil, manure fruits and starchy foods The mycelium is coarse and nonseptate Sporangiophores may be single or show branching In contrast to the white or gray mycelium the spores are usually black or brown The columella is either round cylindric, or pear shaped The sporangium is borne apically on the sporangiophore and its branches

Hormodendrum and Cladosporium

These molds are widespread, especially on decaying leaves Colonies have a velvety olive green or brown surface and are almost black on the reverse side The spores are so arranged

MOORE M New Geotrichum from bronchial and pulmonary infection Ann Missouri Bot Garden 21 349 1934
SMITH D T Oidiomycosis of lungs report of case due to species of Geotrichum J Thoracic Surg 3 241 1934
SWARTZ J H AND JANKELSON I R Incidence of fungi in stools of non-specific ulcerative colitis preliminary report Am J Digest Dis 8 211 1941

Fusarium

This group contains a large number of plant pathogens and saprophytes The mycelium is septate and branched The spores are spindle shaped Chlamydospores are present



Fig 138 *Chaetomium Spiny Perithecia*

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hypersensitive to trichophytin Later trichophytin tests produced a reaction in the skin taken from Bloch but not in the skin of the recipient nor in that of the other donor This proved the sensitivity of the skin cell itself as a basis for the immune reaction

Bruch and Kusunoki showed that repeated injections of trichophytin resulted in a weakening of the reaction at the site of inoculation This was confirmed by Wise and Sulzberger

Jadassohn and Peck noted that patients with dermatophytids regularly manifested immune reactions to trichophytin Sulzberger and Lewis reported eczematous reactions to patch testing with trichophytin

The diagnostic value of the trichophytin test is still questionable for the following reasons Some of the fungi, such as T rubrum (T purpureum) and A schoenleini have a low ensitizing index and a negative test therefore does not rule out infection The test denotes sensitization to a dermatophyte that may have taken place previously, but does not exactly prove that the present eruption is related to the positive reaction obtained It is however a valuable laboratory procedure in conjunction with the clinical and mycologic studies

The Oidiomycin Test

Oidiomycin is a commercial vaccine made from Monilia albicans The author s experience of the diagnostic value of this test coincides with the reports of Lewis Hopper and Montgomery of Biberstein and Epstein and of Staehelin and other workers This test has been found to be of no value as a diagnostic agent Too many patients with no evidence of moniliasis showed immune reactions to this test

Coccidioidin Test

Coccidioidin is prepared from a two months culture of C immitis grown at 37 C

CHAPTER VIII

IMMUNE REACTIONS

Cutaneous sensitization to a fungus, shortly following infection, occurs, but not invariably. The sensitization, as in the case of tuberculosis, may remain for a long time, and therefore the demonstration of the presence of such cutaneous sensitization cannot be regarded as unqualifyingly diagnostic of the skin manifestations. The eruption that may be caused by sensitization to a fungus or to its products is termed dermatophytid.

The Trichophytin Test

Neisser and Plato in 1902 produced an extract of fungi isolated from patients with ringworm. They named this fungus extract trichophytin.

Bloch inoculated animals with Achorion quinckeanum and Trichophyton gypseum and demonstrated that these inoculated animals not only recovered spontaneously but that they also *remained immune for as long as a year and a half*. Furthermore, all these inoculated animals exhibited a hypersensitiveness to inoculation with trichophytin. Bruhns and Alexander, as well as Fuhs, further found that fungi that produced deep-seated lesions had a greater power to immunize than those that produced superficial lesions. Moreover, it was found that the same fungus could produce a deep infection in one animal and a superficial infection in another. In such instances immunity was produced in the former but not in the latter.

Bloch studied the nature of the trichophytin test in the following manner. He sensitized himself to trichophytin by inoculation with a fungus. A piece of his skin and a piece of skin from another person who was not sensitized to trichophytin were used to cover an ulcer of the leg in a third person not

CHAPTER IX

ANTIBIOTICS AND NEWER CHEMOTHERAPEUTIC AGENTS

THE KNOWN antibiotics and chemotherapeutic agents have proved to be of little or no value in the treatment of superficial mycoses Weidman and Chambers noted some inhibitory effect on the superficial mycoses by Bacillus subtilis Lewis and Hopper using a filtrate of Bacillus (subtilis) X G have demonstrated a potent fungistatic power and feel that it has shown promise of clinical value in the treatment of the superficial mycoses Tolmach and Lowenthal, and Hopkins and his co workers feel that clavacin might be useful as a fungistatic agent Other antibiotics are being studied in the various laboratories including the laboratory of one of the authors (J H S)

The terms 'fungistatic" and "fungicidal must not be used interchangeably Fungistatic means varying degrees of inhibition of fungus growth Fungicidal' means killing of the fungus Most preparations available for the treatment of fungus infection partially inhibit the growth of the fungus and are therefore fungistatic agents The mode of action is still debatable because so little is known about the chemistry of the pathogenic fungi particularly the chemistry of the outer coat or capsule The therapeutic results obtained in the superficial mycotic infections with our present armamentarium are probably due to the removal of the horny structure harboring the organism either by epilation as in tinea capitis or by keratolytic action as in glabrous skin involvement

Good results in the treatment of mycotic infection can be obtained either by immune reaction developed by the host or by direct destruction of the fungus with chemicals that are not

The test consists of the intradermic injection of 0.1 cc of a 1:100 *dilution of a standardized coccidioidin*. An erythematous area 0.5 cm in diameter is considered positive, although this does not necessarily mean activity at the present time. This test is highly specific.

Blastomycin Test

This test is done by the intradermic injection of 0.1 cc of a standardized Blastomyces vaccine of 1:1,000 dilution. In patients with an active systemic infection the test may be negative.

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Keeney et al found this organism not very susceptible to the sulfonamides but did obtain complete inhibition of growth in vitro with very high concentrations Conant et al Marshall and Teed report improvement with the clinical trial of the sulfonamides in cryptococcosis

Penicillin

Penicillin has proved effective in the treatment of actinomycosis Large doses are indicated (see section on Actinomycosis) Hendrickson and Lehman recommend that the penicillin be administered partly by the continuous intravenous drip method and partly by intramuscular injection In cases of central nervous system involvement well diluted penicillin can be given intrathecally Penicillin has not produced good therapeutic results in sporotrichosis coccidioidomycosis moniliasis blastomycosis (North American) histoplasmosis and cryptococcosis However Meyer has reported that cultures of Cryptococcus neoformans are killed in vitro by penicillin Hobby and his associates have also found that Cryptococcus neoformans is sensitive to penicillin in vitro These findings are not confirmed by Keeney and other workers who found that penicillin does not inhibit the growth of Cryptococcus neoformans in vitro

Streptomycin

There are scattered reports in the literature on the use of streptomycin in actinomycosis but not enough for one to evaluate its therapeutic index Costigan reports cure of a severe case of actinomycosis within five days after treatment with streptomycin was instituted The dose was 250 000 units in 2 5 cc of sterile water every three hours Streptomycin has not produced good therapeutic results in sporotrichosis and moniliasis Blastomyces dermatitidis is rather resistant to streptomycin

injurious to the host We believe that the reason for failure to accomplish good therapeutic results is the lack of understanding of the chemical structure of the outer coat or capsule of the fungus One can compare the outer capsule to a bulletproof vest Until we can penetrate the bulletproof vest our efforts will be in vain

Studies for fungistatic and fungicidal properties should include in vivo tests as supplementary studies to in vitro tests The fungus may be structurally and chemically different on artificial media as compared with the fungus present in the host This may explain the comparatively poor results obtained in vivo with a proved fungistatic or fungicidal agent by in vitro test

The actinomyces species is sensitive to some of the newer chemotherapeutic agents because this group of fungi is more closely related chemically and structurally to bacteria than the dermatophytes and the yeastlike fungi

Some of the antibiotics and newer chemotherapeutic agents have been reported as producing fair to good therapeutic results in some of the deep mycoses A discussion of the drugs and their therapeutic effects follows

Sulfonamides

Sulfonamides, preferably sulfadiazine, are effective in the treatment of actinomycosis Sulfonamides have been employed with good results in some cases of sporotrichosis In North American blastomycosis the required concentration in vitro for inhibition of the growth of Blastomyces dermatitidis is well above the maximum clinical drug levels tolerated It is therefore not effective if used orally or parenterally Curtis and Grekin report 2 proved cases of histoplasmosis treated with sulfadiazine *Balina et al reported arrest of the disease* in one case of muco-cutaneous involvement There are still controversial reports on the fungistatic and fungicidal effects of the sulfonamides on Cryptococcus neoformans in vitro

Aberrant Differing from a given species or genus in some respects but not easily assignable to another species or genus

Abjunction Formation of septae by the cutting off of spores on portions of growing hyphae

Abortive Not perfect in development

Abstriction *See* Abjunction

Achromatic Without color

Aerial Living above the surface of ground or water

Aerobic Requiring atmospheric oxygen

Agglutinated Firmly attached as though glued together

Aleurospore A simple lateral conidium of dermatophytes

Amorphous Shapeless

Arthrospores Structures formed by segmentation of a hypha into a chain of cells at first cuboidal and later rounded

Articulate Jointed

Ascogenic Producing asci

Ascomycetes Fungi in which the spores are borne in saclike cells called asci

Ascospore Spores borne in a saclike cell called the ascus

Ascus The reproductive cell of the perfect stage of the Ascomycetes containing ascospores

Basidiomycetes Fungi in which spores are borne on basidia, usually four to a basidium

Basidiospores Exospores on a special type of sporophore known as a basidium

Basidium A special type of sporophore bearing exospores

Blastospore A thallospore that arises by budding from the end or side of the parent cell and that may in turn throw out another bud or a mycelial filament without becoming detached and without any period of latency The buds of yeast cells are familiar examples

Gliotoxin

According to Meyer and Ordal gliotoxin showed a fungistatic action in vitro on Blastomyces dermatitidis but was extremely toxic to the chick embryo

Table 5.—*Therapeutic Value of Antibiotics and Chemotherapeutic Agents in the Deep Mycoses*

	Sulfonamides	Penicillin	Streptomycin
Actinomycosis	effective	effective	not enough case reports to evaluate
Sporotrichosis	scattered favorable reports	not effective	not effective
Blastomycosis (North American)	not effective	not effective	not effective
Coccidioidomycosis	not effective	not effective	not effective
Moniliasis	not effective	not effective	not effective
Cryptococcosis	controversial reports	not effective	not enough case reports to evaluate
Histoplasmosis	questionably effective	not effective	not enough case reports to evaluate

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Noojin Ray O and Callaway J Lamar Action of sulfonamide compounds on Blastomyces dermatitidis in vitro Arch Dermat & Syph 47 620 1943

Ecto- Outside (used as prefix)

Ectothrix A fungus growing on the outside of a hair

Endemic Confined to a certain area

Endo- Within or inside (used as prefix)

Endo-ectothrix A fungus growing both within and outside of a hair

Endogenous Originating from inside

Endospore Any spore formed within the membrane of the parent cell

Endothrix A fungus growing within a hair

Eumorphic Well formed

Exogenous Originating from outside

Favic Relating to favus or fungus infection of the scalp

Favoid Resembling a honeycomb

Ferruginous, ferrugineous Reddish brown of the color of iron rust

Filament A threadlike structure, as in mycelia

Fission Cell division by splitting as a process of reproduction

Floccose Consisting of or bearing woolly tufts

Fluorescence The property possessed by certain organic substances, of emitting light of a certain color upon exposure to ultraviolet and other rays

Fruit body The part of a fungus that bears the spore-producing organs

Fungaceous Fungus like

Fungus A thallophyte characterized by the absence of chlorophyll and by the fact that it subsists upon decayed organic matter It has a vegetative structure known as a mycelium and a reproductive structure known as a spore

Furfuraceous Scaly branlike

Fuseau A multiseptate thick walled spore that may be spindle shaped as in the genus Microsporum slender and tapering as in the genus Trichophyton or club shaped as in the genus Epidermophyton

Buff Pale creamy gray to creamy yellow
Cerebriform Brainlike
Chitin A substance, allied to horn, that forms the protective covering of many insects, such as beetles, and that is found also in the cell walls of fungi
Chlamydospores Thallospores formed by the concentration of the protoplasm of a hypha within a swollen portion of the filament, the membrane of which becomes thickened They are purely resting spores and are closely analogous in function to the spores of bacteria
Circumvallate Surrounded
Clavate Thick toward the base, club shaped
Claviform Club shaped
Color of the reverse The color of a culture as seen from the underside of an agar slant or a Petri dish
Concentric Forming rings or zones within one another in a series
Conidia Cells of irregular shape and size borne free and originating asexually from the mycelial threads by a process of budding, septation, or abstriction They may be pedunculated, nonpedunculated, lateral, or terminal
Conidiophore A specialized hypha or sporophore bearing conidia
Copulation Union of sexual cells
Cottony Having a soft and cotton like surface
Crustaceous Having a crust
Cryptograms Plants reproducing by means of spores e g fungi
Dendrite Of a form resembling the branching of a tree
Dermatophyte A fungus parasite found on the skin of man or other animals
Dimorphic Occurring in two forms
Disk The central part of a surface
Downy Having a fine hairy appearance
Duvet A soft finely matted downy coating

ECTO Outside (used as prefix)

ECTOTHRIX A fungus growing on the outside of a hair

ENDEMIC Confined to a certain area

ENDO- Within or inside (used as prefix)

ENDO ECTOTHRIX A fungus growing both within and outside of a hair

ENDOGENOUS Originating from inside

ENDOSPORE Any spore formed within the membrane of the parent cell

ENDOTHRIX A fungus growing within a hair

EUMORPHIC Well formed

EXOGENOUS Originating from outside

FAVIC Relating to favus or fungus infection of the scalp

FAVOID Resembling a honeycomb

FERRUGINEOUS FERRUGINOUS Reddish brown of the color of iron rust

FILAMENT A threadlike structure as in mycelia

FISSION Cell division by splitting as a process of reproduction

FLOCCOSE Consisting of or bearing woolly tufts

FLUORESCENCE The property, possessed by certain organic substances of emitting light of a certain color upon exposure to ultraviolet and other rays

FRUIT BODY The part of a fungus that bears the spore producing organs

FUNGACEOUS Fungus like

FUNGUS A thallophyte characterized by the absence of chlorophyll and by the fact that it subsists upon decayed organic matter It has a vegetative structure known as a mycelium and a reproductive structure known as a spore

FURFURACEOUS Scaly branlike

FUSEAU A multiseptate thick walled spore that may be spindle shaped as in the genus Microsporum slender and tapering as in the genus Trichophyton or club shaped as in the genus Epidermophyton

GENUS A classification embracing related species
GLABROUS Devoid of hair
GLOBOSE Spherical
GUTTATE Spotted as if by drops
GYMNO- Naked or uncovered (used as prefix)
GYRATE Having convolutions
HABITAT The locality to which an animal is native, or in which a plant naturally grows
HETEROGENEOUS Different, unlike
HOLDFASTS Filamentous thallus extensions varying in shape, whose primary function is anchorage or attachment (Rhizopus)
HOST The animal in which a parasitic fungus lives
HYPHA A chain of cylindric or club shaped cells forming a filament
HYPHOMYCETES A group of imperfect fungi, reproducing by free conidia with septate mycelium This is a large group artificially classified together while we await more knowledge of their life history Most fungi pathogenic to man belong in this group
IMPERFECT STAGE The stage in which there is no production of sex spores
INARTICULATE Void of division
INCRUSTED Covered with a thin hard crust
INDIGENOUS Originating in the given region or country
INSPISSATE Thickened
INTERCALARY Growing or developing between apex and base
INTERTRIGINOUS Due to chafing between two surfaces that are near to each other
INTRACELLULAR Within a cell
INTRICATE Interwoven
INVAGINATED Inclosed in a sheath
LACUNAR Covered with indentations
LANCEOLATE Narrow and tapering toward the apex
LATERAL Attached to one side

MACRO- Large (used as prefix)
MEGA Large (used as prefix)
MICRON One-thousandth part of a millimeter A unit of size in microscopic measurement
MIOSIS Reduction of number of divisions of chromosomes
MORPHOLOGIC Relating to form and structure
MUCOID Like mucus or slime
MUCUS Slime
MULTI Many or much (used as prefix)
MULTIFORM Of various shapes
MULTILOCULAR Having many chambers or cells
MULTISEPTATE Having many partitions
MYCELIUM A mass of hyphae or fungus filaments
MYCOLOGY The study of fungi
MYCOSIS Disease produced by fungi in animal tissue
NAKED Devoid of fibrils scales, or other covering
NODULAR BODIES Rounded structures made up of closely intertwined hyphae
OIDIA Having conidia borne in chains
PARASITE An organism living upon and deriving nurture from another living organism
PECTINATE Resembling a comb
PEDUNCULATE Growing on a stalk
PENICILLIFORM Resembling a brush or broom
PERFECT STAGE The stage in which the sex spore is present (the ascus in the case of Ascomycetes the basidium in the case of Basidiomycetes)
PERITHECIUM A rounded oval or pear shaped structure within which asci are borne
PHIALIDE A short spore-bearing structure also known as a sterigma
PLEOMORPHISM The occurrence of more than one independent stage or form in the life cycle of a species
PLURISEPTATE Having multiple transverse septa
PROTOPLASM A complex substance forming the living matter of all vegetable and animal cells and tissues

PSEUDO- False (used as prefix)
PSORIASIFORM Simulating the scaly papular eruption of a skin disease known as psoriasis
PUNCTIFORM Like a pin point or dot
PURPUREOUS Reddish purple
PURULENT Containing pus
PUSTULES Blisters containing cloudy purulent fluid
RACQUET CELLS Club-shaped cells, the clubbed end of one cell being attached to the small end of an adjacent cell
RADIATE To spread from a center
RUGOSE Wrinkled, ridged
SANGUINEOUS Blood colored, pertaining to blood
SAPROPHYTE Any vegetable organism that lives on decaying organic matter
SCLEROTIUM An aggregate of resting bodies of small size composed of a hardened mass of hyphae, from which fruit bodies may develop
SCUTULA The cup shaped crusts found in favus
SEPTATE Divided by a crosswall
SESSILE Attached by the base without any distinct projecting support
SPECIES A classification ranking next below a genus or subgenus, its members possessing certain distinctive permanent characteristics in common
SPINULOSE Having small spines
SPIRAL HYPHAE Simple convoluted hyphae that may take all the forms of a tendril—from a spirillum like form to a closely set coil
SPORANGIOPHORE A sporophore bearing a sporangium
SPORANGIUM A spore case
SPORE Any of various reproductive bodies or cells produced by plants
SPOROPHORE A spore bearing structure
SPOROGENESIS Production of spores
STELLATE Starlike

STERIGMA A specialized hypha to which spores are attached

STRIAE Furrows

SUB Under (used as prefix)

SUBSTRATE, SUBSTRATUM The material in or upon which a fungus grows

SULCUS A groove or furrow

SULFURFOUS Of a sulfur yellow color

SUPER, SUPRA Above (used as prefix)

SYMBIOSIS The living together of two different organisms

SYNONYM An alternative but less approved name of a species or genus

TENACIOUS Tough

THALLOSPORE A cell that forms a part of the vegetative portion of a fungus

THALLUS The entire vegetative portion of a fungus

TRANSLUCENT Transparent, clear

TRUNCATE Appearing as though cut short at the tip by a transverse line

TUBERCLE A wartlike excrescence

UMBILICATE Having a central navel like depression

UMBO A boss or protuberance

VEGETATIVE Growing or food absorbing

VERRUCOSE Warty

VERSICOLOR Changeable in color or of various colors

VESICLE A blister

VISCID Sticky

ZYGOSPORE A sexual type of spore produced by the fusion of two undifferentiated cells

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